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Complete Isolated Plant Service

FURNISHING HEAT, LIGHT, VENTILATION AND WATER SUPPLY AT THE LIMA STATE HOSPITAL

ON THE WAY FROM Lima to Toledo, as one is shot through the fields on the swift interurban, watching the panorama of comfortable farms and busy factories, the attention is arrested a short way outside the city of Lima by a large building in process of completion, and a stack and water tank keeping guard a short distance away, betokening the ever-looked-for power plant. A short walk from the trolley station brings us to the door of the engine room, and as we enter and are cordially greeted by the Chief, F. H. Diehl, we are under the impression that we have discovered a luxurious, modern building for a public bathing house, rather than an engine room. Plenty of overhead room, walls of vitrified brick, and floors of white tile, with windows running almost to the roof, are in strong contrast to the conditions which are met with unfortunate frequency in the engine rooms of our cities.

It is reasonable to expect, however, that in a hospital, where every precaution is taken for cleanliness, the power house would receive like sanitary treatment, and this expectation is fully realized at every point, for careful provision has been made for the well-being of

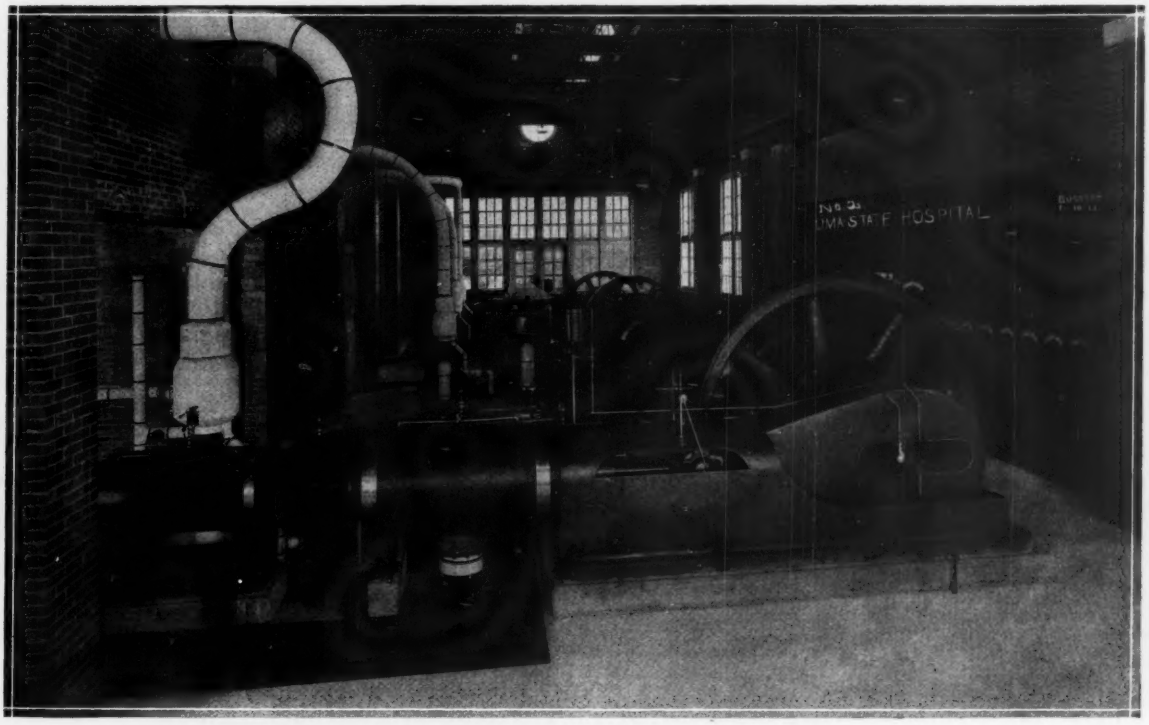


FIG. 1. THE BIG, WELL LIGHTED ENGINE ROOM

machinery and employes, and for securing the best possible continuous service in furnishing light, heat, power and water supply to the hospital building.

All buildings are of concrete construction, with a red brick veneer on the outside, giving a pleasing exterior and a fireproof interior. Elaborate finish has been avoided in the interest of sanitary science, but all rooms are attractive and beautifully light and clean. In corridors the floors are of concrete, but in dining room and assembly hall, and in the passages leading from the

The hospital is erected for the care of criminally insane from the entire State of Ohio, and with this in view, the courts between wings are enclosed by brick walls, but this is the only evidence that the institution is other than for the care of the afflicted.

General Requirements

THE FACT that it is a hospital requires special consideration of heating problems and ventilation, to be sure of a good air supply at all times, and that the

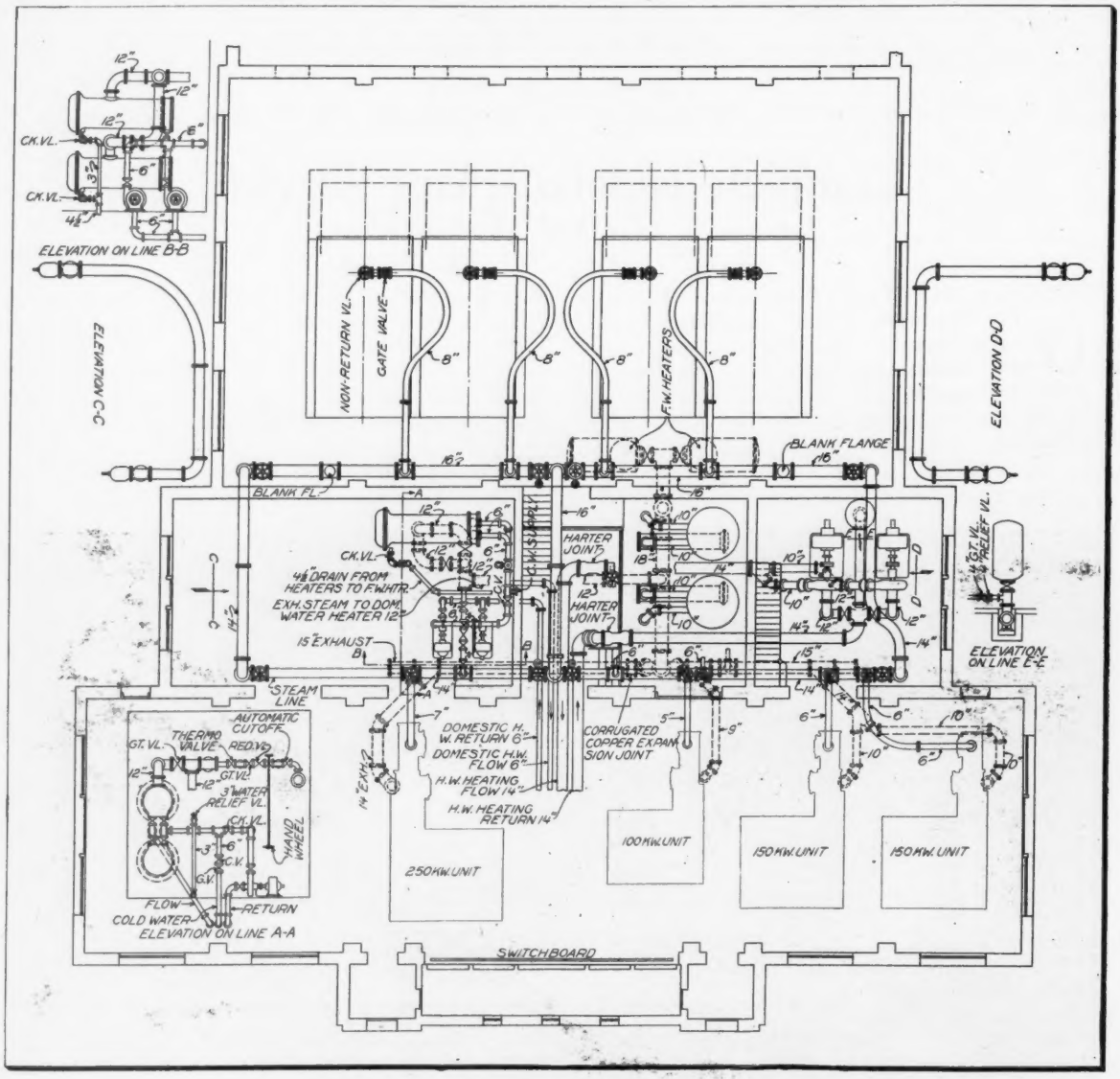


FIG. 2. GENERAL PLAN AND PARTIAL ELEVATIONS OF THE POWER PLANT

service room to these, a cork tile has been used, to overcome the unpleasant noise which might occur from the passage of many feet.

In the power house, proper ventilation, to secure comfortable conditions during the heated months, is secured by the high roof supported on steel trusses, and with the covering of boards overlaid with tar paper, the circulation being secured by turret construction, with louvers and windows in the sides of the turrets.

building shall be free from any disquieting noises, and that it shall have uninterrupted and uniform heating. The fuel to be used is Ohio coal, pea, nut or slack, as may be found most economical, and as the lighting is practically all indoor, and for moderate size areas, there is no occasion for the use of any other form than incandescent lamps.

The area is extensive, because, from its location, land values are not excessive, and it is desirable that all rooms

shall be on one floor. This means long pipe runs for the main supply and return. The requirements for an even heat, sufficient in coldest weather but not excessive in the moderate days of spring and fall, indicate the use of hot water radiation, and the length of supply lines required demands the use of a forced circulation in order to get satisfactory flow.

In such an extended plan, a problem which must be solved is that of uniform flow of the hot water from supply to returns at all points in the system. This has been met by carrying the supply flow pipe of the hot water heating system from the power house straight through to the far end of the court, as shown on the plan, Fig. 7, and taking the risers to supply radiators and nests of coils from the loop, which is carried around the court in the basement corridors, this loop being tapered inversely, that is, the pipe is decreased in diam-

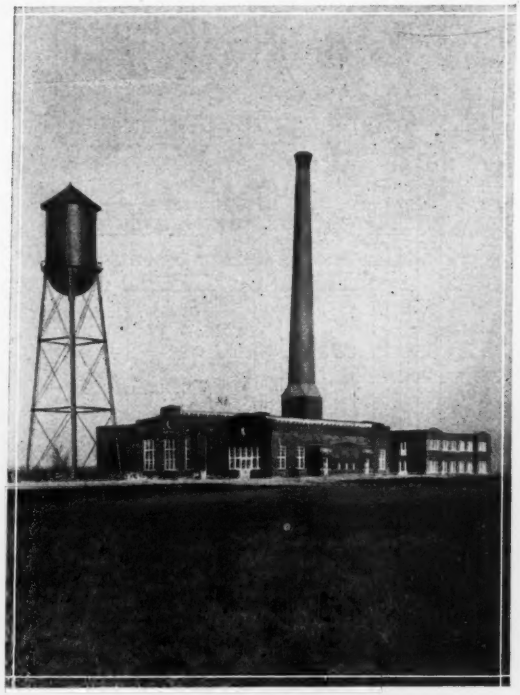


FIG. 3. VIEW OF THE POWER PLANT FROM THE HOSPITAL

eter as it passes around the corridors towards the end of the hospital building nearest the power house. The return pipes begin at the far end of the court with a moderate size and increase as they go toward the power house, up to the point where they join the 14-in. return main, which passes back to the power house in the same tunnel in which the 14-in. supply line is located.

The heating is both indirect and direct, the indirect being by means of hot water radiation and fan units for the operating rooms and the parlors in each wing, while direct is used in corridors and individual rooms. The hot water is heated in the power house by exhaust steam from the engines and pumps, with live steam used to supplement the exhaust when necessary.

Hot Water Heating System

Returning now to the power house, let us examine the apparatus used in this heating system. The circulation through the heating system is produced by 2 Weinman centrifugal pumps, which draw water at 25 lb. pressure from the 14-in. return main, and discharge

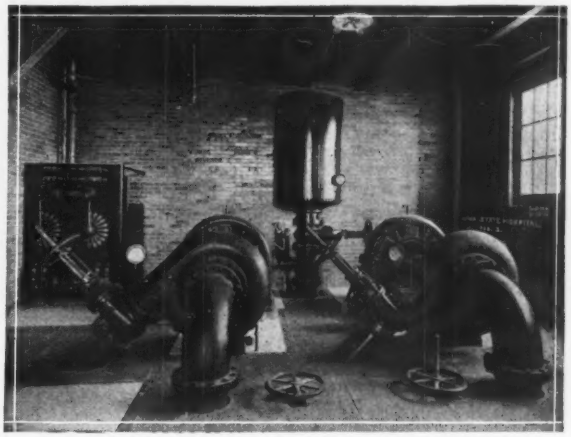


FIG. 4. PUMPS AND EXPANSION TANK FOR FORCED CIRCULATION HOT WATER SYSTEM

it at 40 lb. pressure into the 14-in. pipe leading to the heaters. These heaters are of the closed type, made by the Sims Co., of Erie, Pa., and are 4 in number, 2 of them being exhaust heaters which are operated in paral-

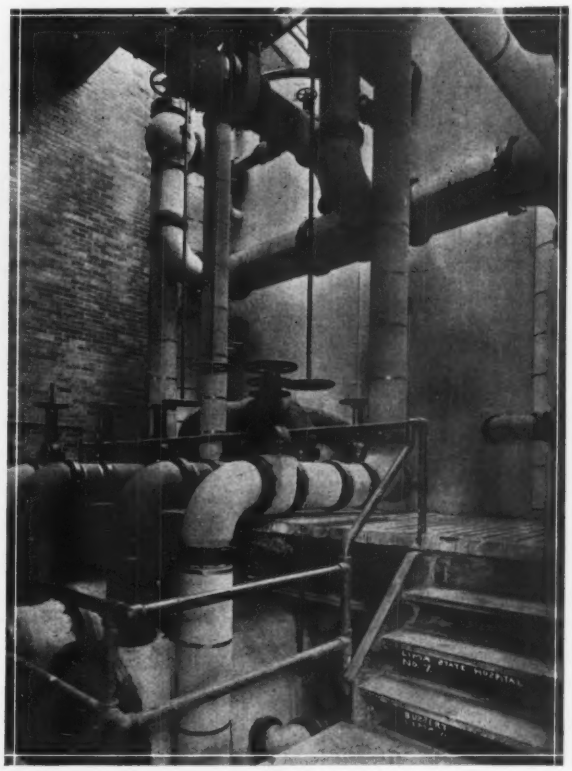


FIG. 5. THE HEATERS FOR THE FLOW SYSTEM

lel, and 2 live steam heaters which operate in parallel and in series with the exhaust heaters.

The pumps for the circulation are driven by Wood 230-volt, direct-current motors of 110 hp., with speed

variable from 660 up to 1000 r.p.m. by means of a Fort Wayne Electric Co. controlling system, and each pump has a maximum capacity of 3000 gal. per minute. To avoid any excess pressure in the system, an expansion tank, shown in the view of the pump room, Fig. 4, is connected to the suction side of the pumps, and is set to open the relief valve at 60 lb. pressure. Throughout the plant, the different pipes are distinguished by the coloring, the return pipes on the heating system being a terra cotta, and the outflow pipes yellow.

The heaters furnished by the Sims Co. are termed converters, those for the exhaust heating having steel shells and tubes, each heater having a capacity for heating 1500 gal. per minute from 170 deg. up to 200 deg., using exhaust steam at atmospheric pressure. Each heater contains 540 tubes, and weigh 36,500 lb. These heaters are set vertically, as shown in the background of Fig. 5, with steam connections as shown in Fig. 6.

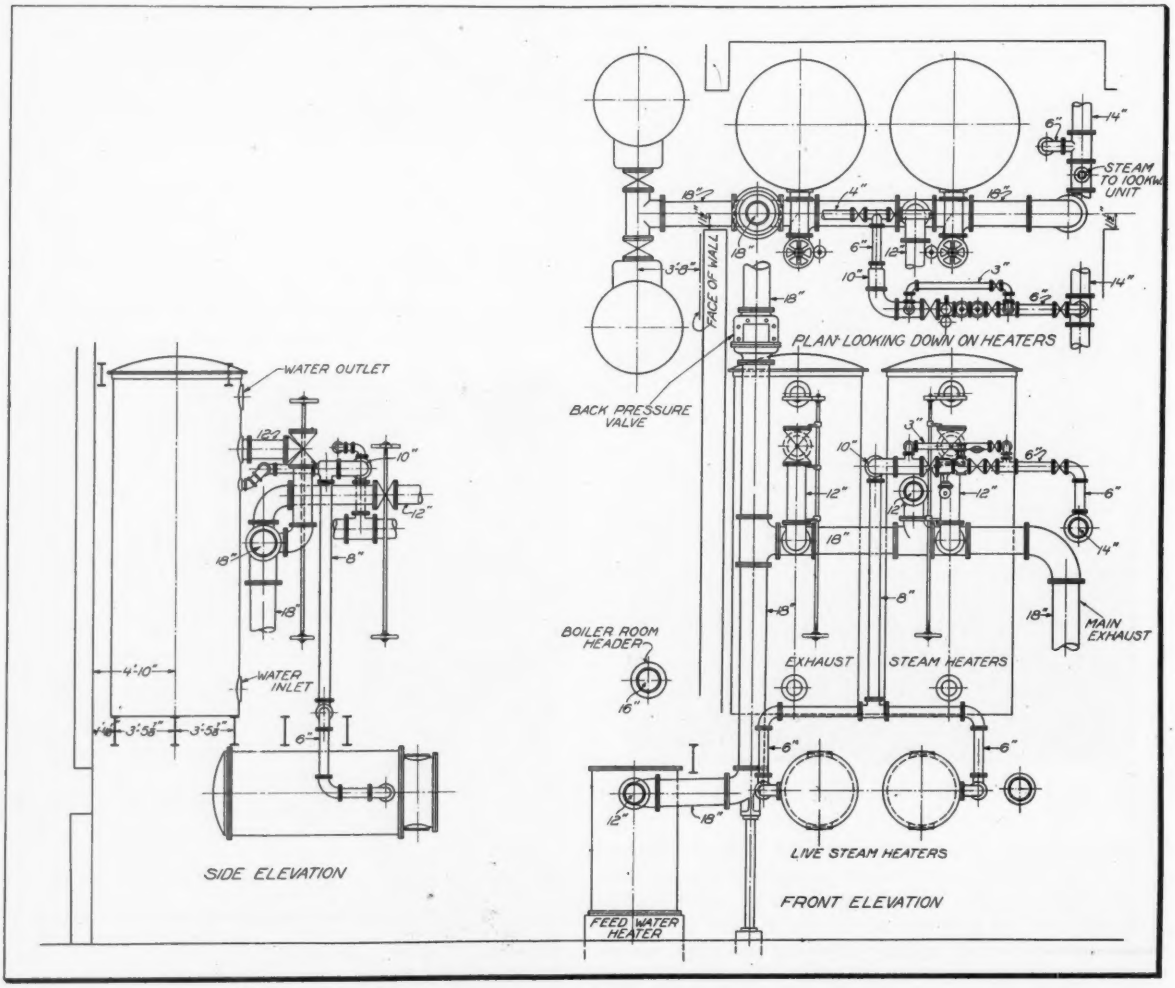


FIG. 6. STEAM CONNECTIONS OF THE HOT WATER HEATERS

In front of these are located the 2 high-pressure converters, which are horizontal type, each containing 270 brass tubes, 1½ in. outside diameter, having one tube head fixed and the other floating. These are of the multipass type, the water passing 6 times the length of the heater between inlet and outlet, through 45 tubes for each pass. The capacity of each heater is 1500 gal. per min., heating from 180 deg. up to 210 deg., using steam at 40 lb. pressure, this steam being reduced from the boiler pressure of 150 lb. by means of a Keiley reducing valve.

The heaters are built to give rapid flow through the multipass, in order to accomplish quick heat transfer from the steam to the water, and also to keep the tubes of the heaters clean. The tube plate covers are divided by partitions into sections to give the several passes, and are so arranged that they can be removed, leaving the tubes free for cleaning or inspection.

The high-pressure heaters are not used so long as the exhaust steam is sufficient to give the temperature required for heating the building, but if the temperature of the outflow water falls below that necessary, the high-pressure heaters are automatically cut in, in series with the exhaust. If given a horsepower rating, the high-pressure heaters would be 4000 hp. each, but this has no particular significance in the present plant.

Leaving the heaters, the water passes to the flow main through a Harter expansion joint and skew fitting,

furnished by the Power Specialty Co., of Chicago, and enters the 14-in. main, which passes through a 500-ft. tunnel, 8 ft. high and 10 ft. wide, to the basement of the hospital building, and then goes on under the center of the court to the far end, where it branches in either direction and is carried in the basement corridors, with risers taken off, as already described, at the necessary points.

tunnel and Harter joints at the junction of the tunnel to the basement corridor, where the pipes rise on account of the difference in level between the tunnel roof and the basement ceiling. In the loops around the basement corridor, expansion joints are inserted every 300 ft. For this system, pipes, valves and bends were furnished by the Best Mfg. Co., of Pittsburgh, which also supplied the pipes for risers and return downflows.

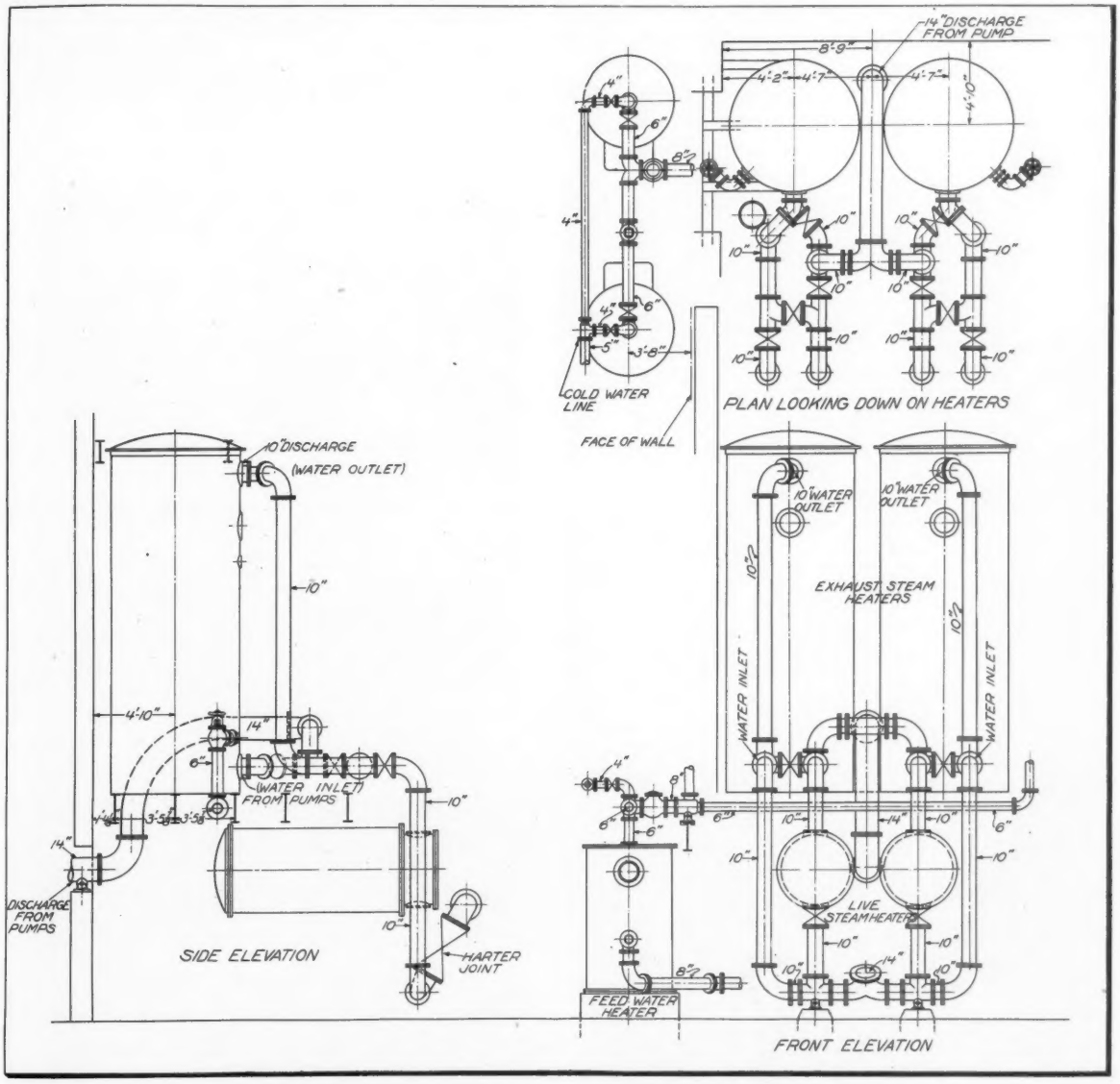


FIG. 6A. WATER CONNECTIONS OF THE HOT WATER HEATERS

Coils for indirect heating are located in basement fan rooms, at the side of the corridor, and are designed to give 6 changes of air per hour, which will heat the rooms to 70 deg. in zero weather, the water at the inlet to the coils being 180 deg., the air at the inlet to the fans being 140 deg., and the final temperature of the air 126 deg. Air going to the clinics, or operating rooms, passes through air washers which, as well as the fans, were furnished by the American Blower Co.

To take care of expansion in the supply and return mains, expansion joints are used in the middle of the

Coils and fans for the indirect system, and radiators for the direct heating, were furnished by the American Blower Co., fans being the Sirocco No. 6, driven by 2-hp. Westinghouse interpole motors at 225 r.p.m. The amount of indirect radiation supplied is 50,000 ft., and the direct, 25,000.

For each ward, a certain amount of indirect heating is provided by a No. 5 Sirocco fan, driven by a Westinghouse 3-hp. motor with 2 interpoles, at 275 r.p.m. For ventilation of rooms where indirect heating is not furnished, and ventilation of corridors and toilets, fans are

installed in the attic, the units being No. 4 Siroccos, driven by 1½-hp. motors, at 370 r.p.m., and this is supplemented by natural ventilation through Burt ventilators placed on the roof.

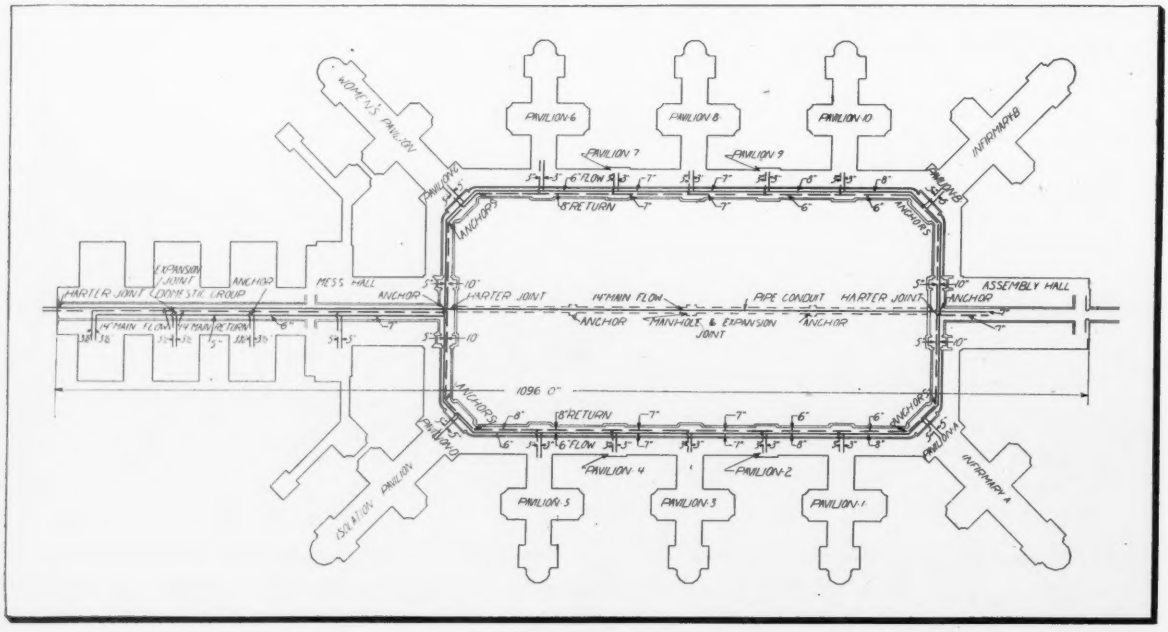


FIG. 7. PLAN OF HOSPITAL, SHOWING ARRANGEMENT OF MAIN HEATING PIPES

Water Supply

Next in importance to heating and ventilation of the building is the water supply. The hot water for domestic purposes is heated in a room to one side of the pump room, by means of 2 Sims closed heaters of horizontal type, shown in Fig. 10, and also on the plan of the power plant, Fig. 2. Each heater has 102 brass tubes, with one fixed and one floating tube head, and is divided into 6 passes, having 17 tubes each, the capacity being 300 gal. per min., raising the temperature from 50 up to 180 deg., with steam at 40 lb. pressure. These heaters use live steam entirely, as the amount required is not large, and during the summer months, when little exhaust is required for heating the building, the remainder will be necessary for heating the feed water for the boilers.

Circulation in the domestic hot water system is provided by 2 duplicate Weinman centrifugal pumps No. 6, each having a capacity of 500 gal. per min., and driven by a 25-hp. Wood motor, with speed variable, by Fort Wayne field and armature control, from 1200 to 1800 r.p.m. The flow and return lines for this system are carried through the tunnel and basement corridors near the heating lines, as shown in Figures 8 and 9. Live steam is furnished from the engine header through a Keiley reducing valve.

FIG. 8. THE TUNNEL TO THE MAIN BUILDING, SHOWING PIPE AND FEEDER ARRANGEMENT

FIG. 9. BASEMENT CORRIDOR IN THE MAIN BUILDING

The cold water system, which furnishes makeup water for the boilers, for the flow heating system and for domestic service, is supplied from a 100,000-gal. overhead tank and stand pipe carried on a structural steel tower, as shown in Fig. 3. This tank gives 128 ft. head, or practically 50 lb. pressure on the water system, and is kept filled by pumps which draw their supply from a 3,500,000-gal. reservoir located some 500 ft. from the power plant. Two Weinman centrifugals are used, having a maximum lift of 23 ft., and a capacity of 250 gal. per min., at 1600 r.p.m., the suction pipe being 6 in., and the discharge pipe from each pump 3 in. These pumps are driven by Northern 20-hp. interpole motors, which are controlled by the head in the stand pipe, and will operate on a drop of 3 ft. head.

returned to the feed water heaters through Keiley traps.

Makeup water is supplied to the feed water heaters, when necessary to keep the proper level, through a float valve which controls the supply line from the cold water system. The feed water system is of extra heavy pipe with gate valves, supplied by the Best Mfg. Co.

From the heaters, the feed water is taken by McGowan duplex simple pumps of the outside packed plunger type, 12 by 8 by 12 in., a duplicate installation of pumps and feed water piping being installed to avoid possibility of shutdown.

Feed water heaters have a capacity of 2000 hp. each, and are made with cast-iron shells, the water running into them over spray saucers, and being filtered, after

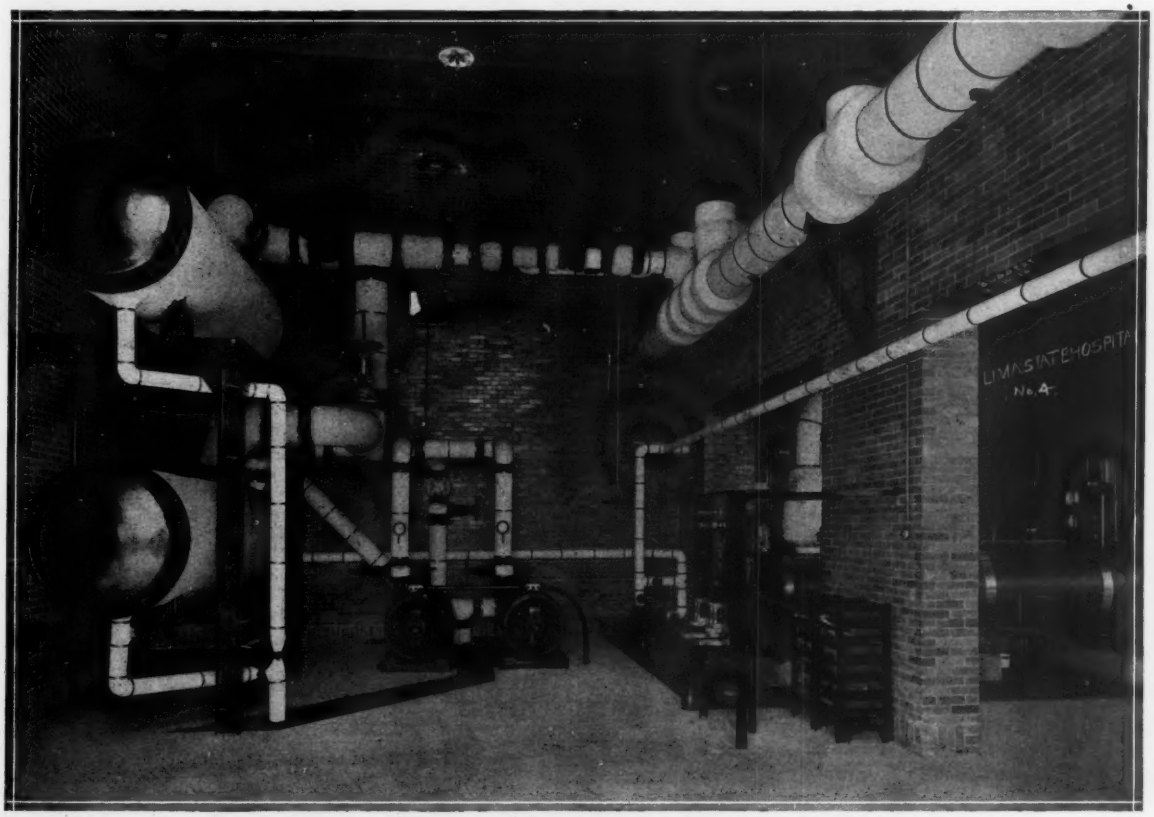


FIG. 10. THE DOMESTIC HOT WATER HEATERS AND CIRCULATING PUMPS

Discharge from pumps is connected to the stand pipe bottom, to the domestic heater, to the flow water and the boiler feed water heater, a check valve being placed between the stand pipe and the other parts of the system to prevent return flow from any part of the system into the stand pipe, in case of a drop in stand pipe pressure.

Boiler Feed

Feed water for the boilers is furnished by 2 Sims open heaters, which received the condensate from the exhaust heaters on the house heating system by gravity drainage, and which have the condensate from the live steam house heaters and the domestic heaters returned to them by means of a Weinman tank pump outfit. Water from the drips on the live steam line is also heating, through a coke bed, which can easily be cleaned without removal from the heater. Feed water piping is distinguished by its blue color, and is carried by overhead lines to the boilers, with a loop in front of each boiler down to a hand control valve within easy reach of the boiler operator. Regular feed to the boilers is through Kitts feed water regulators attached to the water columns.

Boiler Units

The boiler installation consists of 4 McNaul water tube units of 4-pass type, each of 400 hp. rated capacity. These were supplied and installed complete by the McNaul Boiler Co., of Toledo, Ohio, and are fitted with ladders and platforms to give access to the control valves on top of the boilers and in front.

Forced draft is used when necessary, and is supplied by a Clarage No. 170 fan, which forces air underneath the stokers. These are Jones Underfeed, 2 rams to each boiler, supplied by the Underfeed Stoker Co. of America. The draft is regulated, according to the thickness of the fuel bed, by a Kitts automatic speed regulator, operated by the steam pressure of the boiler and, in turn, controlling the speed of the Troy Engine & Machine Co.'s engine which drives the fans.

Coal supply is from bunkers at the rear of the boiler room, which have capacity for 15 cars of coal. These bunkers are filled by running the cars up an incline onto a trestle above the bunkers, dropping the coal from the hopper bottoms. From these bunkers the coal is dropped by gravity through sliding doors to the boiler room floor, and is shoveled by hand into the hoppers of the stokers. Ashes are removed by hand from the ash pit doors at the front of the boilers.

Flue gases, after passing 4 times across the water tubes, are discharged through smoke pipes of concrete construction located under the back end of the boilers, and by these smoke pipes are carried to the 204-ft. brick chimney at one side of the power house, this chimney being 10 ft. diameter at the base, and 6 ft. at the top. The blowoff line is carried along the back of the boilers to a 36-in. by 5-ft. blowoff tank, and the blowoff from each boiler is controlled by a Duro blowoff valve made by the Lunkenheimer Co., and by a Best Mfg. Co.'s blowoff cock.

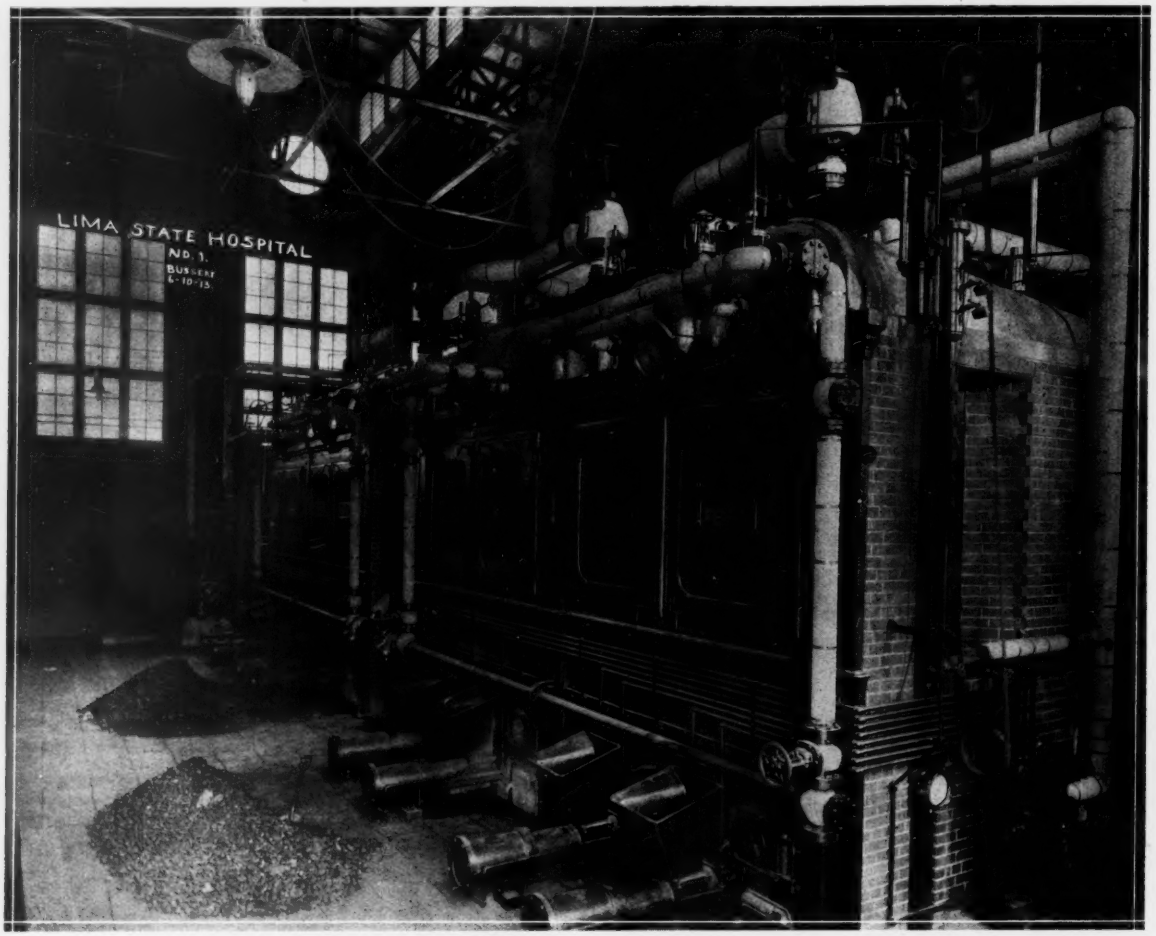


FIG. 11. VIEW OF THE BOILER FRONTS, STOKERS AND FEED WATER CONTROL

LIVE STEAM SYSTEM

STEAM AT 150 lb. pressure is delivered by the boilers through long bends to a header which is carried on the wall between the boiler room and the pump rooms. This header can be divided into 2 sections by means of valves located as shown on the plan, Fig. 2, and is connected at the ends and the center by long bends to the engine header, which is carried through the pump rooms.

The outlet of each boiler is controlled by a Lagonda nonreturn stop valve, followed by a gate valve, and the piping from boiler to header is so pitched that any condensation flows to the header, which is drained by drip and trap into the feed water heater. A Lagonda nonreturn stop valve is also used for the outlet from the engine header to each engine supply line, with the usual throttle valve at each engine, and a Hoppes separator to remove condensation.

The steam piping is all of iron pipe, furnished by the Reading Iron Co., and is made up with Van Stone flange joints, having tongue and socket, and fitted with

Permanite packing, furnished by the H. W. Johns-Manville Co. The piping is covered with 85 per cent magnesia, 2 in. thick, furnished by the Asbestos Products Co., of Cincinnati. Both boiler and engine headers

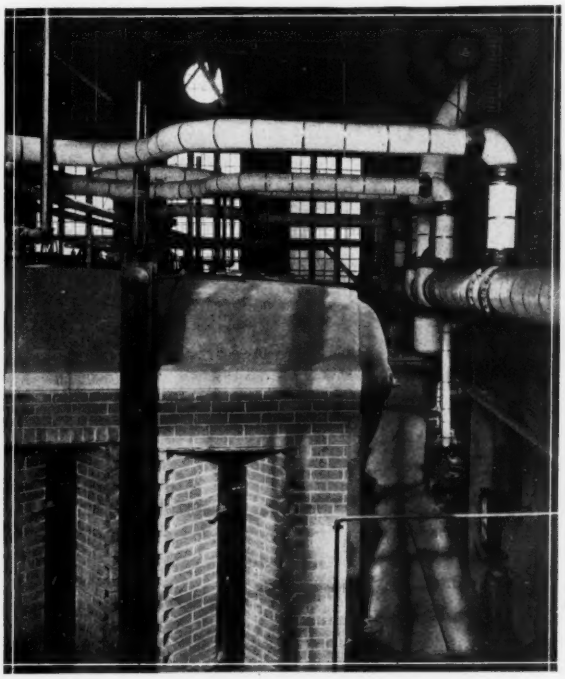


FIG. 12. THE REAR OF THE BOILERS, SHOWING THE BOILER HEADER AND OVERHEAD PIPING

are carried on roller brackets from the walls, and where the piping passes through partitions, it is carried on roller saddles. The piping in tunnel and corridors is carried on strap hangers, located 8 ft. apart.

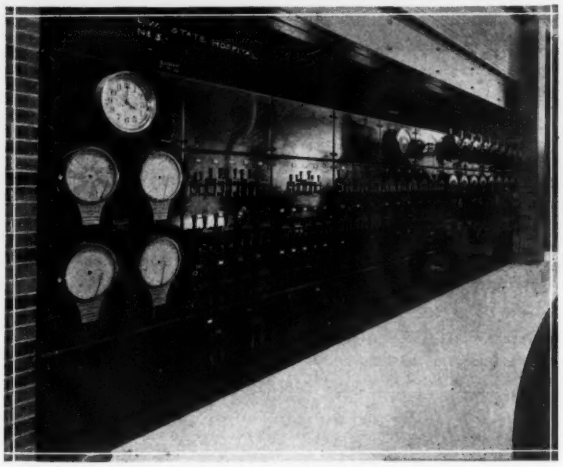


FIG. 13. THE SWITCHBOARD OF THE PLANT

ENGINES AND GENERATORS

GENERATING UNITS for the live steam, which is supplied at 150 lb. pressure, consist of Buckeye engines, direct connected to Westinghouse interpole generators. These are 4 in number, one of 100-kw. capacity, 2 150-kw., and one 250-kw., all of the engines being tandem compounds, and exhausting into pipe located beneath the engine room floor, which leads to a common exhaust main below the floor in the pump rooms. From this main, an exhaust riser leads up and over to the exhaust hot-water heaters, with a branch to the feed water heaters, and an outlet through a Cochrane back pressure valve to an atmospheric exhaust having a Hoppes cast-iron exhaust head.

Live steam pipe throughout the plant is painted white, and the exhaust pipe grey. The feed water heaters are so arranged as to take sufficient steam to heat the feed water to temperature of from 180 to 200 deg., the balance of the steam being used by the flow heaters.

LIMA STATE HOSPITAL

DAILY ENGINE ROOM REPORT.

Date.....191....

Time A.M.	Pressures Steam	Flow Water	Temperatures Out Side	Flow Water	Feed Water	AMPERES No. 1	No. 2	No. 3	No. 4
6									
7									
8									
9									
10									
11									
12									
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
1									
2									
3									
4									
5									
6									

BOILER HOURS.
No. 1 on ..... off .....
No. 2 on ..... off .....
No. 3 on ..... off .....
No. 4 on ..... off .....

BOILER FEED PUMPS.
No. 1 on ..... off .....
No. 2 on ..... off .....

HOT WATER PUMPS.
No. 1 on ..... off .....
No. 2 on ..... off .....

DOM. HOT WATER PUMPS.
No. 1 on ..... off .....
No. 2 on ..... off .....

SOFT WATER PUMPS.
No. 1 on ..... off .....
No. 2 on ..... off .....

LIVE STEAM ON FLOW WATER.
On ..... off .....

LIVE STEAM ON DOM. WATER.
On ..... off .....

COAL USED, LBS.
Day..... Night.....

COAL RECEIVED.

Car No.	Initial.	Time.

CARS RELEASED.

Car No.	Initial.	Time

REMARKS:

FIG. 14. DAILY ENGINE ROOM REPORT

The engines and generators are in all respects standard machinery of the respective manufacturers, the generators being of the 3-wire type, furnishing current at 225 or 110 volts, and running at 200 r.p.m. Above the generators is a 5-ton Reading hand crane to facilitate the handling of parts in overhauling.

CONTROL OF OUTPUT

AT ONE SIDE of the engine room is the switchboard, Fig. 13, furnished by the Westinghouse Electric & Mfg. Co., and equipped with Westinghouse instruments. On this board are 2 panels for the supply of power feeders, equipped with 2-pole switches, and controlling the circuits for the ventilating fans, machine shop, elevators, and the refrigerating room. Three panels are

devoted to lighting circuit feeders, equipped with 3-pole switches which control the different departments and wings, and 4 panels are devoted to the generator control, each panel having an ammeter for each side of the 3-wire circuit, to keep track of the balancing, 2 2-pole switches, a rheostat control, and voltmeter plug contacts. The voltmeter is on a swinging arm, in order to serve all generators and circuits, as may be desired.

It will be noticed from the plan that ample space is provided back of the switchboard to permit of working safely and conveniently in making changes or repairs. Feeders for the power and lighting circuits are carried on frames in the tunnel, and through the basement corridors are carried in conduit on the ceiling.

For lubricating the engines, a Bowser oiling system is installed, the engine and cylinder oil being carried in a special oil room, and the supply of oil for engine bearings coming by gravity feed from a tank located above the domestic hot-water heaters. This supply comes to nozzles above the different bearings, which have individual cups above for use at times when the main system may be shut down.

After passing the engines, the oil flows by gravity to a Bowser filter installation in the basement, and is pumped by means of Marsh duplex pumps to the gravity tank already mentioned. Cylinder oil is fed by means of Hart force feed lubricators attached to each engine.

The refrigerating plant, mentioned in connection with the switchboard, is located in the basement of the hospital, near the kitchen, and is of 25 tons capacity, furnished by the Creamery Package Co., belt driven from a 50-hp. Westinghouse motor. It is fitted with a double pipe condenser, and supplies ammonia on the direct expansion system, to the kitchen and refrigerators, and also brine cooling coils for the cold storage rooms, and for a 10-ton ice tank.

Another auxiliary in the power plant is a 6 by 6-in. Ingersoll-Rand air compressor, used to supply air for cleaning, and belt driven by a 7½-hp. Westinghouse motor.

Economical operation of the plant is secured by the installation of recording devices, to keep track of plant performance, wherever such records will be of assistance. Bristol recording thermometers are provided, to register the outdoors temperature, the temperature of the flow of water and the feed water, and recording gages for the steam pressure and for the water pressure on the supply system. Records of the draft are furnished by a Foxboro recording draft gage attached to each boiler above the furnace, and the flue gas conditions are recorded by a Sarco CO_2 recorder, which can be connected to the breeching of any boiler or to the uptake leading to the stack.

Daily record is kept of the operation of the plant as shown in Fig. 14, and from comparison of these reports from day to day, and month to month, the satisfactory operation of the plant is determined.

Repair Shop

This plant is located at some distance from the city, and will of necessity be obliged, to a considerable extent, to take care of its own repairs and changes, not only for the power plant proper, but for the mechanical installation in the hospital building. It is, therefore, a great convenience to have proper equipment for making such repairs, and a special shop building has been provided for this purpose. At one end is a forge shop, having forge, blower, and other necessary apparatus, supplied by the Buffalo Forge Co. In a room adjoining is a machine shop equipment, consisting of a 12-in. Seneca Falls Machine Co. lathe, driven by a 1.5-hp. Westinghouse motor, with speed variable from 450 to 1350 r.p.m., a 24-in. Pittsburgh lathe, with 5.5-hp. motor, a 12-in. emery wheel, a Hilbert radial drill, with 3-hp. motor, and an Oster pipe threading machine, which will take pipe from 1 in. up to 6 in., driven by a 1.5-hp. motor. All these machines are direct connected. There is also a Parker & Co. shaper, belt driven by a 3-hp. motor. On the second floor of the shop is provided storage space for the different supplies to be carried in stock, and also an equipment of woodworking tools.

The completeness of the plant and the auxiliaries of the installation at all points is a delight to the man who appreciates good work, and a credit to those who have been responsible for the design and installation. It is a pleasure, therefore, to give the credit for the design to E. F. Babbitt, Mechanical Engineer of F. L. Packard Co., of Columbus, O., for the installation and pipe work to S. A. Esswein Heating & Plumbing Co., of Columbus, O.

The plant is now in charge of F. H. Diehl, who is enthusiastic as to the possibilities of satisfactory operation in so complete a plant, and who has devised the report blanks and operating routine, as well as much of the detail of arrangement which contributes to the convenience of operation.

Large power developments in New England seem to be the common news of the day. While the western states started this class of development, New England seems to have determined that it will be in the front rank from now on.

From Rutland, Vt., comes the news of the formation of the Pittsford Power Co., which will invest $250,000 in a power plant near Rutland, at the Chittenden reservoir and the East Pittsford reservoir. The plant is to be built by W. S. Barstow & Co., of New York, the power house being of steel and brick, 45 by 35 ft., 2 stories in height, with 2 direct-connected, 1000-hp. units, generating at 2300 volts. This will be stepped up to 13,000 volts for transmission to Rutland, and 44,000 volts for delivery to the Colonial Power Co., which transmits to cities farther distant.

In Connecticut options have been secured on about 900 acres, at a point on the Lead Mine Brook known as Poverty Hollow, where reservoirs will be constructed, necessitating the possible wiping out of part or all of the village and changing of highways to give storage for power purposes. The options have been secured, according to the reports by C. H. Creston, Jr., of Waterbury, Conn., and rumor is divided as to whether the project is under control of the Stone & Webster Co., of Boston, or the New England Power Co., which has developments in Massachusetts and Vermont, on the Connecticut and Deerfield Rivers.

Pumping Irrigating Water

DIFFICULTIES ENCOUNTERED WITH PUMPS, BOILER FEED WATER, BAGGED BOILERS AND OIL FUEL. BY A. G. SOLOMON

FEW people outside the district have any idea of the extent to which irrigation is carried on in the South and West. Nearly all rice and cane plantations depend entirely on irrigation for their existence. Rice lands have to be actually covered with water and in nearly all, if not all, plantations, this water has to be pumped from some river or else from wells. Those pumping plants are, as a rule, out in the country, and away from the path of visiting engineers.

The irrigation companies make contracts with the plantation owners to supply abundant water for a season at a fixed price per acre, and if the water is not where it should be, some one must be to blame. The evaporation alone amounts to about 1¼ in. every 24 hr. in the southern part of Texas.

It has only been during the past 10 yr. that rice has been cultivated to any great extent in this country. Now, Texas and Louisiana devote thousands of acres to raising this valuable grain.

Some irrigation plants really consist of 2 separate pumping stations, known as the lower and upper lift. The lower lift is the station which takes water from a river and discharges into a canal. Those canals are sometimes 15 or 20 mi. long and vary in width according to the land through which they were dug. In places where the land is low, they spread out and form small lakes. The canal acts as the reservoir for the upper lift station, which is situated at the far end of it. This station takes the water from the canal and discharges into irrigation ditches, which are dug throughout the plantations.

The upper lift pumping station is on the level ground, same as any other engine room, but the lower lift station is a different proposition entirely. It is built so as to give the pumps water without too high suction lift; this means that the floor of the engine room is from 35 to 50 ft. below the surrounding land level.

The water in the rivers gets very low during a long dry summer, and it would be impossible to lift the water if the pumps were not down near the bed of the stream. I remember a case where the water got so low that we had to make a sort of makeshift dam by filling bags with sand and putting them across a narrow part of the river, so that our pumps would not lose suction.

Take, for instance, a volute pump with a 45-in. discharge and 72-in. suction, and the distance from the center of the shaft to the river level 18 ft., and this suction line about 100 ft. long. The engine will, of course, have to be shut down, and the discharge gate shut. Then the air must be expelled and the water drawn into the suction. The priming is done by means of an ejector, or steam jet, which is tapped into the top of the pump casing.

On a pump of the size before mentioned, a 3-in. steam line is used for the ejector, and sometimes it will take an hour or more to get the water; if the greatest care is not taken, the water will be lost again while opening the discharge gate, and then all will be repeated as before. The large, high-speed volute pumps lose suction easily if the shaft packing is not good or the water seal fails, or if the steam pressure gets low and the pump slows down.

BOILER FEED WATER

THE WATER used in the boilers is, as a rule, full of scale-forming sediment; or else sediment that stays soft like putty and lodges in the tubes in large quantities. The boiler feed water is taken from the canal either with a steam jet or a pump and discharged into settling basins, where it travels from one basin to another till the sand and dirt appear to have been deposited and the water is reasonably clear. Those settling tanks or basins number from 4 to 6, according to the condition of the water.

From the last basin the water is pumped into a heater and then into the boilers. Open heaters are mostly used, as the closed type would be hard to keep anything like clean.

In one plant there was practically no scale in the boilers, but the mud deposit was even more troublesome and expensive than scale would have been. In cleaning one of the boilers, we found some of the 4-in. tubes so full of soft mud that a 1¼-in. pipe would have to be forced through first, and then scrapers would have to be used with an increasing diameter, till the size of the tube was finally reached. Water, even under a heavy pressure and thrown from a small nozzle, did not seem to have much effect.

BAGGED WATER TUBES AND REPAIR

THE 2 bottom rows of tubes in the Babcock and Wilcox and the Heine boilers were always bagging and leaking. A bag as big around as a quarter would first appear, and it would keep coming down till the metal was stretched to its limit, and then the tube would begin to leak. The leak would be very small at first, but in a short time a stream would be pouring out. Sometimes as many as 3 of these leaks would start in one tube in a length of 4 or 5 in.

It was never only one tube that would give out, but we would have perhaps 6 or 7 in the bottom row and 3 or 4 in the second from the bottom, at the same time. When they got as bad as that, of course the fires would go out and we would cut out the boiler and empty it as soon as the brick work was somewhere near cool. Then a man would get into the furnace and locate the bad tubes. That certainly was far from a pleasant job.

After the bad tubes were located and marked on the outside the hand-hole plates were taken off at both ends and the tube ends were ripped and bent in so that they would turn in the holes. Even then some of the tubes would be hard to turn, as they would be bent so much that they would touch the tubes on either side.

Then the hot and dirty work began. A lot of short planks were soaked in water and thrown into the fur-

nace to stand on. In this connection let me remark that we burned oil and had the furnaces so arranged that there were no grates and the bottom of the ash pit was the furnace bottom. The oil burners were put in at the ash pit doors.

One man handled the 3-wheel pipe cutter and 2 or 3 more men turned the tube with chain tongs. The tubes were cut off just in front of the bridge wall and the 2 pieces pulled into the furnace and thrown out the door. They could not be taken out whole on account of the bags and blisters. Sometimes we could not stay in the furnace long enough to cut a tube even half way through, but would make 3 or 4 trips in and out.

Then the new tubes were put in place and wedged at one end to hold them while the other end was rolled. By the time the tubes were rolled, other men had the plates and headers cleaned, and the plates were put on as fast as the rolling was completed.

Then the boiler was filled and fired up and in many cases another one was let down right away, so the work went merrily on. And those men seemed to enjoy it in a way. They were interested and would work like demons day and night and often the next day without rest.

And this constant disturbance of the baffles and upper part of the bridge wall was another problem to contend with. Even under the most favorable conditions patching baffles is a job not to be desired. But it had to be done and was done fairly well with asbestos cement.

The flame from an oil burner will find the small holes to short-circuit through and when this once gets started it will soon seriously affect the steaming qualities of the boiler. I have seen holes in the baffles which would let the heat and flame go direct to the smokestack, doing very little toward evaporating water. In bad cases and where the fires are forced, the flame will be seen coming out the top of the stack like a blast furnace.

Fuel Oil Supply

One irrigation plant with which I was at one time in close touch, was located 3 miles from a railroad and the fuel oil was emptied into a tank alongside of the track. From this receiving tank, it was pumped to storage tanks close to the boiler room through a 2-in. line. A locomotive type boiler was used to supply steam for the pumps and one night we had the misfortune to have a fireman who, I now believe, knew little about a boiler. At any rate, he burned the crown sheet so badly that it was beyond repair.

Something had to be done at once, as the oil in the storage tanks was as low as it could well be. So a gasoline traction engine and a geared power pump were obtained. It did not take long to do a rough job of connecting and we were soon pumping again.

Then we noticed that the discharge pressure from the power pump kept gradually getting higher and higher and a new problem presented itself for solution.

We were using Mexican crude oil and there is a lot of asphalt-like substance in it. This sediment had been collecting in the 2-in. line till the opening was not ½ its original size. Steam had little, if any, effect on loosening this substance and we were beginning to find ourselves in a bad fix.

We got a half tank car of kerosene and pumped it through the line and it did what was expected very well. By using a few barrels of kerosene once in a while we kept the line clean enough to pull through the season.

This asphalt-like substance would block up the burners and also pile up in big hard lumps in the furnace against the checker baffles, which were used to break and distribute the flame. And it was also found in large quantities lodged between the tubes, and this would at times get so bad that it affected the draft seriously.

Draft was one thing we were shy on for 2 of the boilers toward the latter part of the season.

One new boiler had recently been installed and was all ready except the stack, and we were trying to figure a way to cut into one of the other stacks, instead of putting up a new one. Our planning was brought to an end one stormy Sunday by the stack over a Heine boiler blowing down. Luckily it fell away from the boiler room and did no damage except setting fire to the place. The fire was quickly put out and then, without any study or planning, we put a 1-in. steam line into the piece of stack still standing and, using that as a blower, we fired up again. By a little experimenting, we got fairly good results and kept our 2 pumps going.

Then we turned our attention to the new boiler. It was getting close to the end of the season, so we just fixed up a piece of stack to extend through the roof and called it good enough. It was all rough and quick work and there certainly was no economy in our fuel oil burning. Our only object was to keep that plant going till the rice and cane crop was safe and then the whole place would be shut down and completely overhauled, and it surely did need it.

As the plant then stood the boiler room was about 300 ft. from the engine room and 50 ft. above it.

The condensation was excessive and at times, when the steam pressure was low, those 2 engines had a hard time getting rid of the water without losing the cylinder heads or twisting valve stems.

The engines were tandem compound condensing high-speed Corliss with the nonreleasing type of valve gear. If I remember rightly, the cylinder dimensions were 18 by 36 by 32 in., and the speed 175 r.p.m.

One day a valve stuck and the reach rod was snapped in two. We had no handy way of welding it, so we cut off about ¾ in. from one of the broken ends and cut a 1½-in. pipe thread on both broken ends and put in a 1½-in. coupling. It held fine and was not taken out during the rest of the season, although we had a new reach rod ordered at once.

The discharge valve gates were operated by hydraulic pressure, but most of the time we had to help with a chain hoist on account of sand and dirt.

Our drinking water, as also the water used for cooking, was obtained by tapping the steam main and running a couple of lengths of ½-in. pipe in the canal to condense the steam and then collecting this condensed water in a 5000-gal. tank. It was all right for cooking and good enough for drinking, except at times when we had no ice; this happened quite often, as the ice had to be hauled 6 miles over rough roads.

Scientific Boiler Control*

KEEPING TRACK OF COMBUSTION BY CO_2 RECORDS; LOSS FROM LOW CO_2 AND HOT FLUE GASES. BY F. D. HARGER

IN later years, science forced its way, gradually, into many fields of engineering practice, and this has resulted in increased economy and efficiency in many ways. The general desire to do away with guesswork and to turn to good account the valuable fruits of scientific research is responsible for the attention, which is, at present, bestowed upon steam boilers and furnaces.

Anybody who has had an opportunity to study engineering features and improvements abroad will agree that in this country we are not giving our boiler plants the attention which they deserve.

For years past, steam users, with a few notable exceptions, have been content to leave the problem of firing almost entirely in the hands of the firemen who were supposed to be capable of dealing, unaided, with so difficult a matter as coal combustion. Nobody would

FIG. 1. PRECISION CO_2 RECORDER WITH CIRCULAR DIAL

ever seriously suggest that a good fireman should tell his steam pressure without the use of a pressure gage, yet the idea is quite general that this same fireman should be able to judge whether he is using the right thickness of fires, with correct draft over the grates, or pressure under them, whether he is feeding coal at the proper rate and whether he is obtaining the correct exit temperatures, simply by looking at his fires. Experience without guidance cannot teach these things and the difference between good and bad firing is really sufficiently costly to warrant careful investigation.

I had occasion to observe an interesting bonus system installed in a plant in New Jersey, the other day. Four firemen worked on 4 furnaces. A gas analysis apparatus was installed and the average of the percentages of CO_2 was taken daily by the engineer in charge. For every hour where the percentage of CO_2 was above 12 per cent a bonus was paid and, in addition, that man who had the longest and best record received an additional premium of $2 at the end of the month. I saw this man paid the sum of $5.35 and I was assured that this system pays well. There is an interesting rivalry between the men, and this rivalry undoubtedly must result in increased efficiency.

Often, mere novices are winning over the old men by a good margin. Granting, therefore, that some scientific guide as mentioned above, or an indicator would be of real value to the man in charge, our next point is to investigate in what direction this is most likely to be found, in a shape which will be really practical and also simple in its application. As the burning of fuel in the furnace is a chemical process, it is not surprising that a guide should have been found in a continuous and automatic analysis of the products of combustion.

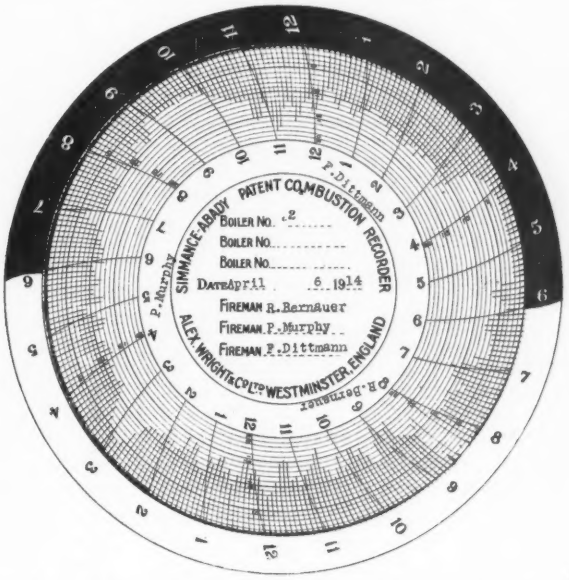


FIG. 2. CHART FROM CO_2 RECORDER SHOWING THE VARIATIONS IN FIRING

I am aware that the operating engineer is not anxious to be led into a labyrinth of chemical terms and symbols, and I propose to deal with the chemical side of the subject only so far as it forms a necessary part of the practical side of the matter. I do not suggest that you should erect a laboratory in your stoke hold, with a college graduate chemist, to teach you what to do with your boilers. This is unnecessary, as there are CO_2 recorders on the market, instruments which produce, automatically, a certain number of analyses per hour of at least one of the products of combustion, and the most important one, that which the chemist calls CO_2.

I hope to show you that these recorders must be considered quite as indispensable to the working of boilers as a steam engine indicator is to the care of engines. To prove my case I must explain first the term CO_2, its connection with the furnace gases and its bearing upon the degree of efficiency of combustion.

*From a paper before the Modern Science Club of Brooklyn, N. Y.

CO_2 stands for carbon dioxide that means a compound of carbon, C, and oxygen, O, in chemical union in the proportion of 1 part of carbon to 2 of oxygen. We need not stop to relate what chemical union means; it is sufficient to say that CO_2 is formed when carbon, which is the principal constituent of coal, is brought into intimate contact with a sufficient amount of oxygen, as is done by forcing air through the hot firebed of the furnace. This chemical union is nothing more nor less than

TABLE I.

The figures show the percentage loss in coal as a result of the flue gas having a percentage of CO_2 and a temperature as per the intersecting columns. The air temperature is assumed to be 60 deg. F.

Percentage of CO_2	300 deg. F.	420 deg. F.	540 deg. F.	Temperature of Waste Gases.
4	39.40	59.00	78.8	
5	32.00	48.00	64.0	
6	26.30	39.50	52.6	
7	22.50	33.75	45.0	
8	19.70	29.50	39.4	
9	17.52	26.28	35.0	
10	15.77	23.65	31.5	
11	14.33	21.50	28.6	
12	13.14	19.70	26.3	
13	12.10	18.15	24.0	
14	11.25	16.90	22.5	
15	10.50	15.75	21.0	

combustion, and this of itself explains the importance of reliable information about the percentage of this CO_2 gas present in the exit gases which pass to the stack; for the carbon in the coal is not always burned to CO_2; it may be changed only into CO or carbon monoxide, which is a chemical compound of carbon and oxygen in equal proportions. Any particle of CO_2 may be retransformed into CO if it should in its passage through the firebed and flues to the chimney come in contact with highly heated atoms of carbon. Now, both CO_2 and CO are colorless gases and the proportion in which they are present in the furnaces can only be detected by chemical analysis. To show how important it should be to every owner and responsible engineer of a power plant to maintain a continuous record of CO_2, I will say that a pound of dry carbon, burned entirely to CO_2, gives us heat equal to 14,000 B.t.u., while the same weight of the same carbon burned to CO yields only 4450 B.t.u. It follows that, when we discover a low percentage of CO_2

TABLE II.

Showing an avoidable loss of 10 per cent of coal.
Bituminous coal taken at three prices—$2.00, $3.00, $4.00 per ton.

Consumption		Avoidable Loss		Cash Value of Loss per Annum		
Tons of Coal per Day of 24 Hours	Tons of Coal per Year (330 days)	Day	Tons per Year of 330 Working Days	$2.00	$3.00	$4.00
5	1,650	½	165	3.30	4.95	6.60
10	3,300	1	330	6.60	9.90	13.20
15	4,950	1½	495	9.90	14.85	19.80
20	6,600	2	660	13.20	19.80	26.40
25	8,250	2½	825	16.30	24.75	33.00
50	16,500	5	1650	33.00	40.50	66.00

The above figures show the monetary loss occasioned by 10 per cent waste of coal on the basis of the difference between 11.5 and 6.5 per cent of CO_2 and a fairly low flue temperature.

in our exit gases, we must be losing a lot of heat which should have been absorbed by the water in the boilers and, vice-versa, a high percentage of CO_2 should mean that we have secured the best transmission of heat generated by combustion of the fuel to CO_2.

Before showing now what it really means to have a low or a high percentage of CO_2, showing on the chart of a recorder, I must add a few remarks regarding the temperature of the stack gases. Since economizers have become popular it is often erroneously considered an advantage to have a high temperature in the flues leading to the economizer. It is said that this will mean a higher temperature for the water in the economizer and the fact is quite overlooked that, had the heat been utilized in the boiler itself, the total efficiency would have been much greater. I use this illustration to emphasize the importance of continuous records of the temperature of the exit gases; this temperature should be kept at the lowest possible limit with a good draught for this reason. A high temperature at the stack, showing that a large part of the heat which should have been utilized is being wasted, is due either to conditions unfavorable to complete combustion of the fuel and the gases given off by it immediately over the grate, or too little heating surface, so that the gases do not allow the boiler sufficient time to absorb all or most of the heat carried in them. As far as the first case is concerned this would, in all cases, be clearly indicated on the CO_2 recorder by a bad record, but the latter possibility renders it desirable to take records of the temperature of the exit gases in addition to the analyses of the percentage of CO_2.

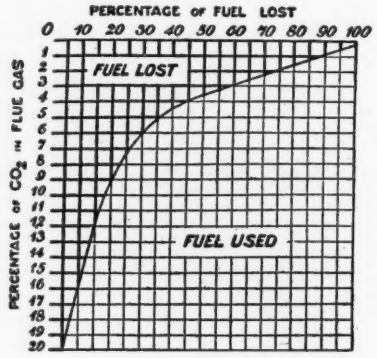

PERCENTAGE OF FUEL LOST
0 10 20 30 40 50 60 70 80 90 100
PERCENTAGE OF CO2 IN FLUE GAS
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
FUEL LOST
FUEL USED

FIG. 3. FUEL LOSS AS CO_2 CHANGES, WITH FLUE GASES AT 420 DEG. F.

Considering the losses in a boiler furnace, due to the CO_2 content and the temperature of the exit gases, briefly, Table I shows that if an engineer can, by the use of a CO_2 recorder increase the percentage of CO_2 in the exit gases from 4 per cent to 15 per cent, he will have effected a clear saving on his coal bill of 21½ per cent. If he can reduce his exit temperature at the same time, this must result in even greater saving.

Even if only 12 per cent can be maintained, it will be worth doing, for the saving will amount to over 20 per cent, compared with a record of only 5 per cent. It is well known that exit temperatures considerably higher than those given in the table are frequently met with, when the loss is also, of course, proportionately greater. I have chosen 5 per cent as the lowest figure because, where reasonable care is taken, lower percentages are not often obtained; but it must be said that where CO_2 recorders are not in constant use, an average of more than 7 per cent is seldom obtained. This is true even of those plants where occasional snap tests with the Orsat are taken, although these tests may show better results.

These savings in per cent, translated into actual dollars and cents, are shown in Table II.

Occasional tests cannot be expected to provide a reliable indication of the average condition, as the firemen know very well when these tests are taken, and there is no indication that the good results obtained during these tests are maintained throughout the day and night. Such a guarantee can only be furnished by a CO_2 recorder.

Now it is said that it is one thing to show up bad results and another to remedy them, and it must, of course, be realized that a telltale, for that is what a CO_2 recorder really is, cannot automatically remedy the defects which it points out. It is, however, not difficult to see that such a machine is of great value when one remembers that stoking consists, after all, of but a few manipulations very simple in themselves. Give the firemen the means to know what is going on, and good results will be obtained in a short time.

Before referring to the various ways in which a recorder can assist in the improvement of the conditions of combustion, let me draw your attention to one of its functions, which is not generally recognized as important, but which has, in my opinion, a great practical value; I mean the moral effect upon the men. A machine which will show up attention as well as neglect and waste of money at all times, night and day, which cannot be bribed or intimidated, meddled with or changed, giving a just and true record without favor or bias, is a good paying investment beyond all doubt. To this must be added that an intelligent stoker cannot help developing an interest in the records of his work as made by the recorder. As I said before, in plants where several men are engaged, a friendly rivalry will be set up between them and each man will do his best to outstrip the others. Yes, I have even seen bets on the best CO_2 record.

Let us now examine the various manipulations which will affect the CO_2 content of the exit gases. There is, first of all, the air supply. This is undoubtedly the most important factor. We cannot feed just the quantity of air which would furnish the required volume of oxygen; we must have an excess. But this excess should be kept as low as possible, for every pound of excess cold air that we admit to the furnace not only lowers the temperature of the furnace but, in addition, it must be heated up to the temperature of the exit gases which caused great waste. Especially with forced draft operation, the likelihood of furnishing a large excess of air is great. In addition to a CO_2 recorder, therefore, a draft gage will be found extremely valuable for the guidance of the firemen.

The points of next importance are the thickness of the fire bed and the intervals between firing, speaking chiefly of hand-fired boilers. The thickness of the fire bed varies considerably with the draft available, the duty required of a boiler and the class of fuel used, but the general rule applies that it should be as even as possible and free from holes through which great volumes of air can enter. Great improvements have been made by cleaning quickly, avoiding as much as possible the inrush of cold air when the doors are open. Finally, there are such considerations as repairs to the settings, and accumulations of soot in the tubes, which cut down the draft, besides reducing the conductivity of the boiler plates, as shown in Table III.

Each gain adds its little share to the general improvement with the inevitable result that after a month or two the CO_2 record and with it the coal bill, will show that efficiency and economy have been materially increased, and this without any structural alterations or additions and without any considerable outlay. All this is perfectly well known; but if every fireman has some ready means of studying the results of his actions, he will quickly improve in his work. A CO_2 recorder is some sort of an automatic calculator. It adds, divides, subtracts and shows the result of a man's work, whether good or bad, which is what one really wants. It may be added that these machines are quite inexpensive to maintain, costing only about 50 cents a month, and their life is long. Provided they are given a little attention, say as much as is given to a feed-water heater, oil separator, or other saving apparatus, they can be relied upon to give accurate and reliable results.

TABLE III.

Showing the loss in conductivity of boiler plate due to different thickness of soot deposit.

Thickness of soot	Loss per cent
Clean plate	0.0
1-32nd inch	9.5
1-16th inch	26.2
1-8th inch	45.2
3-16ths inch	69.0

THERE HAS been organized in the city of New York, the American Society for Fire Prevention, to carry on a vigorous campaign all over the country, for fire prevention. A. W. Herbst has been chosen as director of safety of the society, and a strong advisory board of experts has been appointed. The need for such a campaign is indicated by the fact that the loss by fire each year in the United States is some $200,000,000 in cash, aside from the loss of business and wages, which is estimated at $500,000,000. It is determined that 75 per cent of the losses are due to noncompliance with and nonenforcement of the ordinary principles of fire prevention, and that the other 25 per cent are traceable to arson, carelessness, ignorance, and lack of proper supervision. There is disagreement among different bureaus in regard to requirements, and conflict of authority between officials, which works hardship to owners, and one object of the society will be to harmonize such requirements, so that they may be fully understood and readily complied with.

Comparison of the fire losses in American and European cities shows that while the loss of the United States per capita runs from $2.24 in cities of more than 300,000 population up to $3.47 in cities of less than 10,000, in Europe the highest cost per capita is $1.67 in cities of from 50,000 to 100,000, and runs from this down to 37 cents per capita in larger cities. The per capita loss in different countries is as follows, averaged for some 297 cities: United States, $2.39; England, 44 cents; France, 92 cents; Germany, 19 cents; Ireland, 45 cents; Norway, 25 cents. The services, co-operation and records of the society will be offered absolutely free to all persons and corporations interested in the work for which the society is formed. The society will be maintained solely by voluntary contributions of its members, and has completed arrangements for issuing a monthly magazine known as "Fire Prevention."

Governing and Oiling Systems of Westinghouse Turbines

THE valve control system, which might be spoken of as "oil governing," as used with nearly all Westinghouse turbines of all types above 1000 kw. capacity, is as follows:

The governor is of the flyball direct-acting type as shown in Fig. 1, being driven from the main shaft through a worm and gear. The governor, through a system of linkage and oil relay, controls and operates the primary and secondary steam valves. Oil for operating the relay is furnished by the turbine oil pump, which is situated below the governor and driven through a set of gears, the drives being on the end of the governor shaft. Two types of pumps are used, a simple rotary for the smaller turbines and for the larger, a reciprocating pump driven by a Scotch yoke arrangement, transforming the rotary motion of the pump shaft to the reciprocating motion of the pump pistons.

It was found expedient to use the latter type of pump when relatively large quantities of oil (as 80 gal. per min.) are circulated. The oil pressure on the discharge side of the pump is around 65 to 80 lb. pressure (gage), varying for different turbines. The high-pressure oil is used only in operating the oil relay, that used in the oiling system proper being at about 4 to 8 lb. pressure. This reduction in pressure is obtained through a reducing valve, which may be adjusted to give any discharge pressure desired.

High-pressure oil is carried direct to the oil relay, A, shown in Fig. 1. This oil, depending upon the position of the oil relay plunger, is admitted either below or above the oil operating cylinder piston, B, and so raises or lowers the oil operating piston, closing or opening the valves and so admitting a smaller or larger amount of steam to the turbine. It may be noted, in passing, that the secondary valve does not come into play until the operating cylinder piston lever arm to the secondary valve has moved till the adjustable screw on the top of the secondary valve comes in contact with the lever; so, as is obvious, the primary valve only is affected until the machine is loaded up to the point when the secondary comes into play.

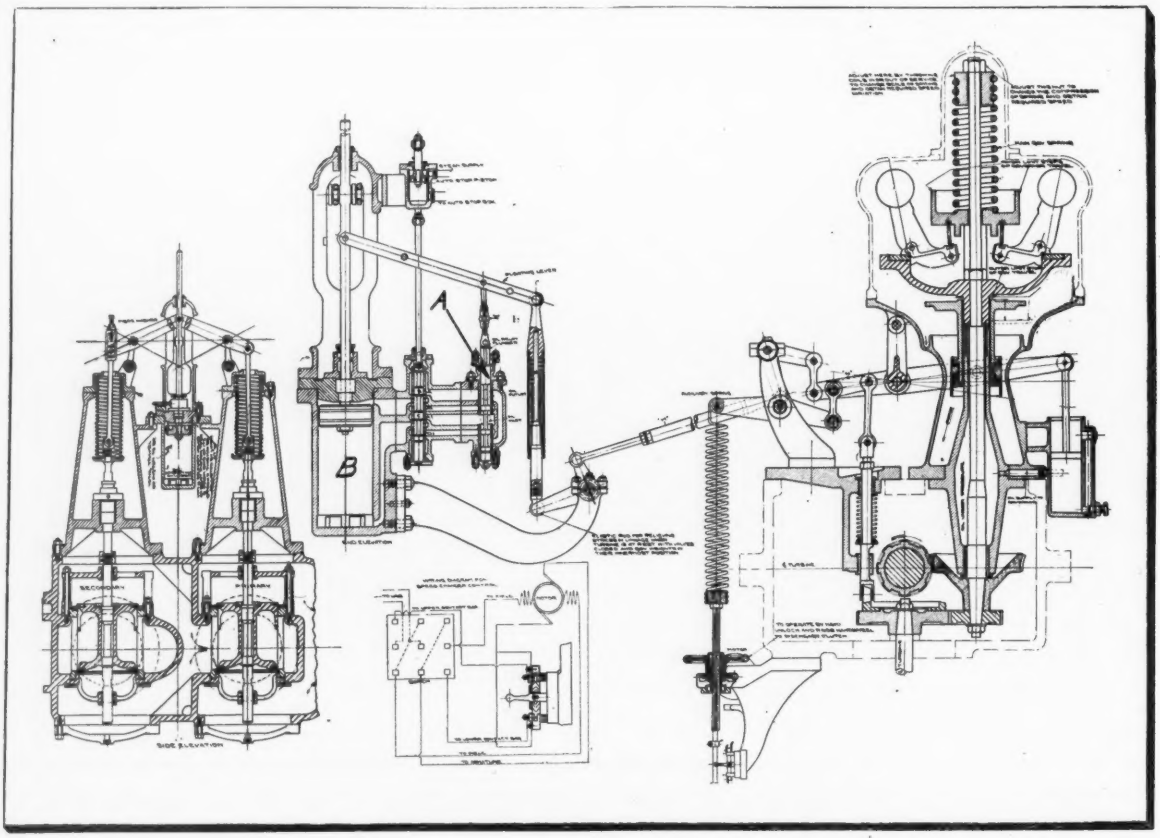


FIG. 1. GOVERNING MECHANISM OF WESTINGHOUSE TURBINES

The action of the complete mechanism is as follows: Assume the machine running at some load. If the tendency is for the load to increase, before the valve has had time to act, the speed will obviously fall off. This decrease in speed causes the governor balls to close up

slightly and through the linkage the floating lever is raised. The operating piston remaining stationary (for the moment), the oil relay plunger is raised, admitting oil above the operating piston and at the same time connecting the operating cylinder below the piston with the discharge outlet, which communicates with the general oiling system. Then the operating piston moves downward until the oil relay plunger shuts off the oil supply, at the same instant closing the oil discharge opening. If the operating cylinder has moved downward too far, admitting too much steam to the turbine, for the load required, the speed increases and the reverse action takes place; that is, the oil relay plunger moves downward, admitting oil to the lower side of the operating cylinder, etc.

Speed regulation of the turbines using this system is around 2 per cent from full load to no load and for the pressure on the system is only a few pounds (4 to 8 gage), just enough to insure a positive flow of oil to the parts to be lubricated. The oil, after it passes through the reducing valve and that which has passed through the relay system, flows to the cooler. The cooler consists of a chamber filled with tubes (generally of a copper composition) through which cold water circulates. By means of baffle plates, the oil which flows among the tubes is directed along a more or less fixed path, flowing through the cooler in the form of a sort of sine curve, the oil coming in contact with the tubes several times. The design is such that the warm oil meets the warm water tubes and the cold oil the cold water tubes, giving the most efficient cooling arrangement possible.

From the cooler, the oil goes to 4 main points, the 2 turbine bearings and the 2 generator bearings. The supply to the turbine bearing at the governor end of the

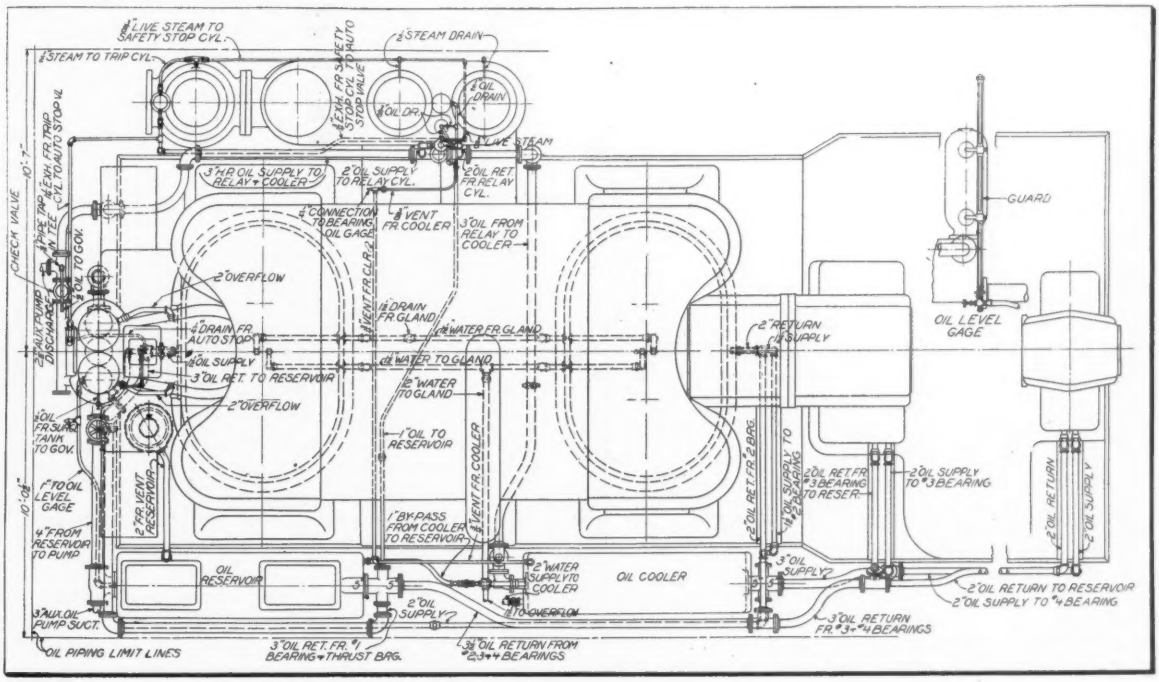

LIVE STEAM TO SAFETY STOP CYL.
STEAM TO TRIP CYL.
STEAM DRAIN
OIL DRAIN
EXH. FR SAFETY STOP CYL. TO AUTO STOP VL.
LIVE STEAM
3" H.P. OIL SUPPLY TO RELAY & COOLER
2" OIL SUPPLY TO RELAY CYL.
2" OIL RET. FR RELAY CYL.
CONNECTION TO BEARING OIL GAGE
VENT FR COOLER
3" OIL FROM RELAY TO COOLER
GUARD
CHECK VALVE
PIPE TAP
EXH. FR TRIP CYL. TO AUTO STOP VL.
OIL TO GOV.
2" OVERFLOW
VENT FR GLAND
DRAIN FR GLAND
WATER FR GLAND
2" RETURN & SUPPLY
OIL LEVEL GAGE
DRAIN FR AUTO STOP
OIL SUPPLY
3" OIL RET. TO RESERVOIR
WATER TO GLAND
2" WATER TO GLAND
2" OVERFLOW
OIL FR SUP. TANK TO GOV.
1" OIL TO RESERVOIR
VENT FR COOLER
1" TO OIL LEVEL GAGE
2" FR VENT RESERVOIR
4" FROM RESERVOIR TO PUMP
1" BY-PASS FROM COOLER TO RESERVOIR
2" OIL SUPPLY TO #3 BEARING
2" OIL RET. FR #3 BEARING TO RESER.
2" OIL RET. FR #2 BRG.
2" OIL SUPPLY TO #2 BEARING
OIL RESERVOIR
2" WATER SUPPLY TO COOLER
OIL COOLER
3" OIL SUPPLY
2" OIL RETURN TO RESERVOIR
2" OIL SUPPLY TO #4 BEARING
2" OIL RETURN
2" OIL SUPPLY
2" OIL SUPPLY
TO OVERFLOW
3" AUX. OIL PUMP SUCT.
3" OIL RETURN FR #3 & #4 BEARINGS
OIL PIPING LIMIT LINES
3" OIL RET. FR #1 BEARING & THRUST BRG.
3½" OIL RETURN FROM #2, 3 & 4 BEARINGS

FIG. 2. OIL PIPING FOR LUBRICATING SYSTEM OF WESTINGHOUSE TURBINES

instantaneous charge from no load to full load or vice versa, the speed variation will not be over 5 per cent, which shows the sensitiveness of the governor action and that of the complete system.

There is a vibrator on the governor which imparts an oscillating motion to the linkage which is imparted or transmitted to the oil relay, oil operating cylinder and valves, insuring a free and sensitive action of the whole. A more or less large amount of oil passes through the oil relay, due to the movement of the operating cylinder; but as the oil for the oiling system is throttled, doing no useful work, it matters not the slightest from an economical standpoint, whether or not any or all of the oil passes through the relay.

Oiling System

The oiling system as used with Westinghouse turbine generator outfits is simple. As mentioned before, machine is the largest, as it also lubricates the thrust bearing, the governor and all parts in the governor case. If there is a direct-connected exciter on the end of the generator shaft, its bearings are lubricated from the supply that goes to the adjacent generator bearings. After serving its purpose, this oil flows by gravity to the oil reservoir, from which it flows (also by gravity) to the pump suction, where it is again started on its journey to the oil relay and through the oiling system. There is a vent open to the atmosphere from the reservoir or the pump suction which allows any air to escape that may have gotten into the system. The oil cooler and reservoir are fastened to the side of the bed plate on the side opposite the valves and steam chest, which are also fastened to the bed plate. Facing the unit from the turbine end, the general or standard arrangement is the valves and steam chest on the right side and the cooler and reservoir on the left side.

Electrical Machinery and Appliances

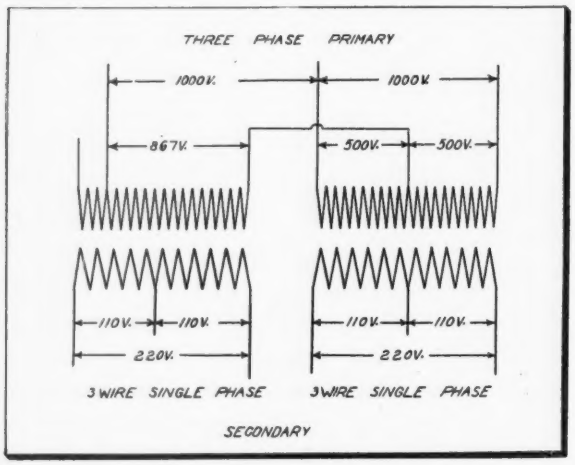
For Generating, Transmitting and Using Current

Lighting from 3-Phase Circuits

THREE-PHASE TWO-PHASE TRANSFORMATION REDUCES LIGHTING COMPLICATIONS IN FACTORY. BY IRVING W. BOOTH

IN modern manufacturing plants, the motors are usually run from 3-phase circuits. The lighting should be supplied from the same source of power. Lamps are single-phase apparatus, so the question of balance becomes a troublesome one.

In general, a 3-phase circuit, unequally loaded, requires 2 changes (if not more) of lamp groups to bring about balance. In a 3-wire direct-current or single-phase circuit, it is only necessary to select a group of lamps corresponding to one-half the inequality of balance and transfer them from the heavy side to the underloaded side.



TRANSFORMER CONNECTIONS

The 3-phase system of lighting, run either 3 or 4-wire, is a 3-circuit problem and it is often difficult to find a proper grouping. The 3-wire system is really 2 circuits, and these lend themselves to very simple arrangements.

In the case of long factories, we can run 2 main circuits the full length of the building, each circuit to take care of its side of the mill. The 2 sides of a mill require about equal lighting and the circuits will be equally loaded.

Each circuit may be run 3-wire. The lights themselves will be supplied from cross circuits of smaller wire than that of the mains, place one, 2-wire, cross circuit in each bent. The first cross circuit connected between one outside and the neutral, the next between the other outside and the neutral, the third the same as the first, the fourth the same as the second, and so on down the whole length of the mains. The 3-wire circuit is now balanced, for the light required in half the bents will equal the light required in the other half when the division is alternate, all the way down the mill.

This gives us 2 equally loaded and balanced 3-wire circuits on each floor. These will almost automatically remain equally loaded and balanced through the many rearrangements of lighting required by a growing plant, and the numerous changes in the art of illumination.

For connecting into the 3-phase circuit, we use 2 straight transformers, wound to the ratio between the power and the lighting circuits. The secondaries have the usual 220-110-volt leads for running the 3-wire circuits. The primaries have 4 leads, the usual 2 at the ends of the coil for full voltage, one from the center for 50 per cent voltage, and one at 86.7 per cent of full voltage. The 2 extra taps add nothing to the expense of the transformers. They are connected up as shown in the figure.

The first is connected directly across one phase by full voltage taps. The second is connected to the center, or 50 per cent tap of the first, with its own 86.7 per cent tap connected to the remaining phase lead. In this way, it will be seen that, when the secondary circuits are nearly equally loaded, the 3-phase primaries are balanced.

In practice, this gives good results which can not be excelled with straight 3-phase lighting, and its endless trouble of changing from phases to phase, with the changes in the plant and the lighting systems. Nor is the economy of copper the least point in its favor.

The transformer core losses are unbalanced about 15 per cent, but this small item is of no practical importance whatever.

Before leaving this subject one further use of this system will be mentioned, simply as a matter of curious interest. It is not recommended for general use, as it may cause trouble, unless under the constant and immediate supervision of an expert electrician.

Note, first of all, that the lighting is by 2 independent single-phase circuits and there is no connection of any kind between them, though they are spaced 90 deg. apart in phase, in order to balance the 3-phase circuits. Keeping this in mind, what follows will be clear.

In one plant where this system of lamp connections was installed, the question of lighting out, and fire circuits came up. After the machinery shut down at 6 p. m.

it would be necessary, in the winter, to run one of the main generators 10 or 12 min., to keep the lights on the mills until the help were all out of the factory gates.

One of the steam-driven d.c. exciters is run all night for lighting the yards, boiler rooms, etc., leaving about 200 hp. available for lighting with the main units shut down. Therefore, a d.c. circuit was run to each mill and connected to the lighting system as follows: The positive was connected to the neutral tap of one transformer, the negative to the neutral tap of the other transformer, both connections on the secondary side.

The lighting out lamps are legged in between the 2 sets of mains wherever necessary, using the nearest end of a cross circuit from each side. The lighting out lamps are spaced down the middle of each floor only. The neutrals are used throughout to save a little calculating when wiring up.

At a few minutes before 6, the lighting out lamps are switched on and we have the curious phenomenon of the same wires carrying both a.c. and d.c. current; "A direct-current 2-phase system," as one wireman called it.

There is no additional drop in voltage on the a.c. circuits when carrying the d.c. load. The d.c. shows no measurable drop whatever whether the a.c. is on or off. Probably all the copper on both legs of the phantom circuit assists in carrying the d.c.

Practical Electrical Engineering

ASSEMBLING DIRECT-CURRENT GENERATORS; SUGGESTIONS FOR HANDLING HEAVY PARTS. BY NORMAN G. MEADE

GENERATORS and motors of any considerable size are, as a rule, shipped in 3 parts: the lower half of the field, the upper half of the field, and the armature. The smaller details, such as brush yoke, brush holders and series shunt are also shipped separately and attached to the machine after the frame and the armature are in position. In this article the erection of horizontally-split frame direct-connected machines only is described, as erecting a vertically split machine is comparatively simple and was briefly described in the issue of Nov. 15, 1913, in the Practical Electrical Engineering article.

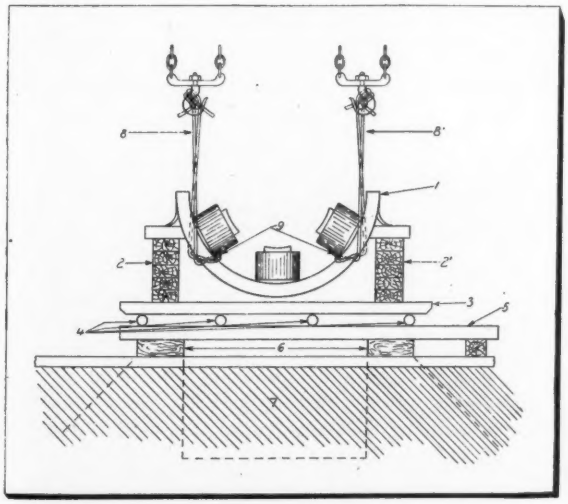


FIG. 1. PLACING THE LOWER HALF OF THE FIELD

Foundations for generators of the direct-coupled and engine type, almost universally used at present for moderate and large capacities, are as a rule included in the plan and templet for the engine or other prime mover foundations, so that the electrical man on the job rarely has occasion to give this part of the job much consideration other than seeing that proper conduits are provided for the cables leading from the generator to the switchboard.

The usual manner of shipping the 2 parts of the field frame and the armature is to mount the parts on skids and hold in position by suitable blocking and bolts. When erecting an engine-type generator, the first operation is to place the lower half of the field frame in position; Fig. 1 shows the manner of doing this.

In the figure, 1 is the lower half of the field frame; 2 and 2^1, supporting blocks; 3, skids; 4, rollers, preferably made from short lengths of iron pipe about 3 in. in diameter; 5, timbers laid across the foundation cap stones, 6; 7, pit in foundation; 8 and 8^1, rope slings. Where a traveling crane is available, erecting work is greatly simplified; but one is seldom found in a moderate or small size plant. Chain hoists must be resorted to and

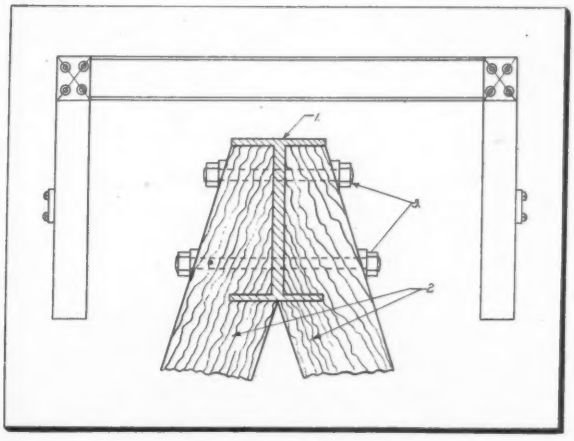


FIG. 2. VIEWS OF AN I-BEAM TRESTLE

in engine rooms where there are no overhead beams or girders, some means for supporting the hoists must be provided. A convenient arrangement, consisting of a large trestle, is shown in Fig. 2. It consists of a steel I-beam, 1, supported by heavy timber legs, 2, bolted to the beam by bolts, 3. The trestle should be sufficiently high to provide ample clearance from the machine being erected.

Referring again to Fig. 1, the trestle is placed over the foundation pit so that the foundation is straddled

and 2 chain hoists are suspended from it, the hooks and part of the chain only being shown in the figure. The rope slings are next attached to the frame with heavy burlap placed at 9 to prevent the rope from abrading the field coil. The bolts attaching the half of frame to the skids are then removed, the frame slightly raised by means of the chain hoists and the blocking, skids, rollers and timbers are taken away, after which the half frame

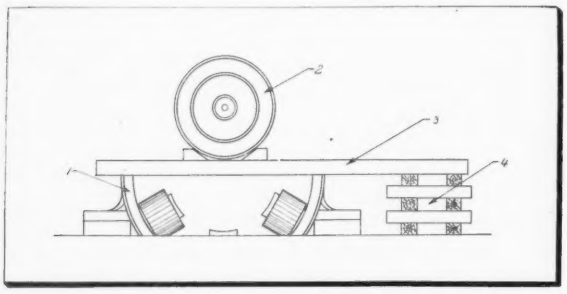


FIG. 3. FIRST STEP IN PLACING ARMATURE

is lowered onto the foundation. The half frame should be carefully leveled by means of steel wedges, then firmly bolted down. A dam should be provided around the feet on the foundation and the space between the feet and the cap stones filled with cement of such a consistency that it will readily flow into all crevices.

Pedestals for the bearings are frequently made as part of the bedplate casting; but often the outboard

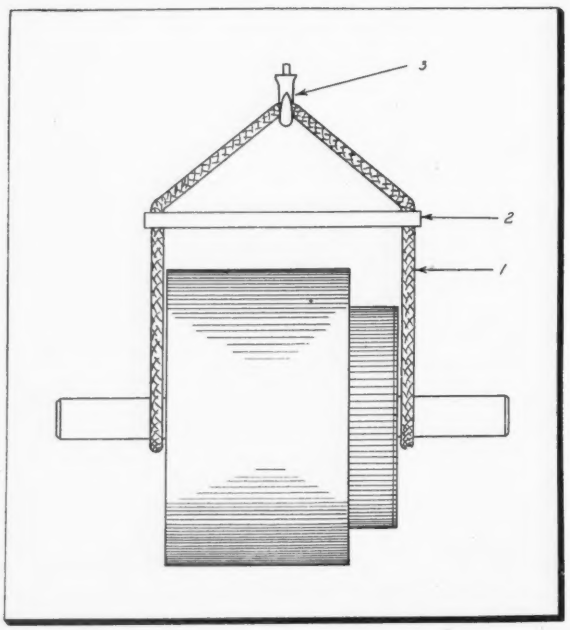


FIG. 4. ROPE SLING FOR ARMATURE

pedestal is a separate casting bolted firmly to the bedplate; this is done to facilitate handling the generator parts in case repairs are necessary to windings. All the bearing castings are comparatively light, but the chain hoist is usually found convenient for handling the heavier parts.

Before the armature shaft is lowered into position, the bearings and oil wells should be cleaned thoroughly, making certain that no gritty particles remain where they are likely to get upon the bearing surfaces. A cloth thrown over the open bearing while working with the armature is a precaution which may save a great deal of trouble later on.

Direct-connected, engine-driven generators usually have the armature flywheel and crank disk all mounted upon one shaft; when driven by a water wheel it is common practice to couple the armature shaft to the turbine shaft. In either case, the pressing of the armature upon the shaft is a job for the machine shop or factory and is done in the plant only when special conditions arise, so we will not discuss that step at this time, but will consider the armature mounted upon the shaft.

We are then ready to place the armature in position, the preliminary operation being shown in Fig. 3, in which 1 is the lower half of the frame resting on the foundation, 2 the armature, 3 timbers, and 4 wood blocking. The trestle is first placed over the blocking,

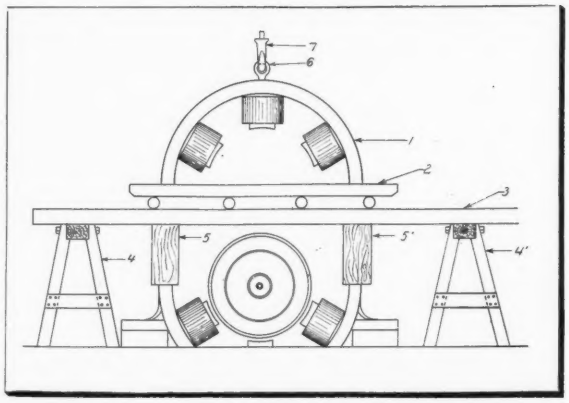


FIG. 5. PLACING THE UPPER HALF OF THE FIELD

4, and the armature hoisted onto the timbers, 3, when it is rolled into a position over the central part of the frame and blocked; the trestle is moved over the armature and it is slightly hoisted to permit the removal of the timbers, after which it is lowered into position, being careful to have the oil rings in their proper locations before the shaft reaches the bearings.

The weight of the armature should never be supported by the commutator as it would be liable to cause permanent injury. Figure 4 shows the correct way of handling an armature; 1 is a rope sling held open by the notched stick, 2, and supported by the hoist hook, 3.

Next in order, is placing the upper half of the field frame in position, as shown in Fig. 5. This operation is somewhat more difficult, owing to the greater height to which the part has to be raised. In the figure, 1 is the upper half of the field frame; 2, skids; 3, timbers; 4 and 4^1, short trestles; 5 and 5^1, blocks for reinforcing the timbers 3, 6 lifting ring and 7 hoist hook. The upper half may be raised onto the timbers, 3, by means of the large trestle and hoists, or an inclined runway be provided extending from the floor to the timber level and the part drawn up on rollers by means of the chain hoists working at an angle. After the upper half is central with the lower half of the frame, it is slightly raised

and the timbers and blocking removed; it is afterward lowered into position. The surfaces of the joints between the upper and lower halves should be scraped and polished with a piece of fine emery cloth so as to present a bright appearance.

After the halves of the frame are bolted together, the armature must be carefully centered, for if it is not, the pull on the side nearest the field magnets will be tremendous. A convenient and simple device for testing for central position is a hard-wood wedge, which is inserted between the pole faces and the periphery of the armature. If the wedge enters the air spaces an equal distance all around, the armature is central; but, if the wedge enters a greater distance at one point, it indicates that the armature should be moved in that direction.

Assembling the brush rigging is next in order. The brushes should be ground so as to conform perfectly with the commutator by placing a piece of sandpaper under a brush, one at a time, and drawing it backward and forward, with the tension on the brush. The commutator should be warmed by running the generator for a few hours and the nuts tightened. Frequently a commutator will be found eccentric at this time and it may have to be turned down. This leaves the machine ready to be connected up with the switchboard.

New Electrolytic Lightning Arrester

FOR the protection of cable systems, motors and generators connected directly on a line without transformers, or transformers with weak insulation on their end turns, the Westinghouse Electric & Mfg. Co. has recently introduced a lightning arrester, known as Type A K, with a charge-and-discharge resistor in series with the standard electrolytic element. The resistor serves to limit the charging current to a low value and to damp out any surges that might result in charging, particularly if the system contains enough capacity to produce resonance. The arrester is made for use on circuits up to 14,500 volts.

The electrolytic element consists of treated aluminum trays stacked one on another, separated and insulated from each other by porcelain spacers on the periphery of the traps, the number of trays in a stack depending upon the normal voltage of the line on which the arrester is to be used. The stacks of trays are suitably supported in frames, and each tray is filled with electrolyte. The stacks are then arranged in welded steel tanks and immersed in oil.

In actual operation, a film of the electrolyte forms on the surface of each tray. This film has a high resistance at normal voltages, but the resistance becomes very low at abnormal voltages. It, therefore, forms a free path for abnormal voltages or static charges; but upon cessation of the abnormal stress, the film instantly regains its high resistance.

The arrangement of the trays and the electrolyte is such that the electrolytic element acts as an electrostatic condenser. The flow of current, due to the capacity of this condenser, varies inversely as the frequency of the circuit. Thus, at normal commercial frequencies, the flow of current is small; but at the high frequencies of lightning discharges and static disturbances, considerable current flows through the element, increasing the action of discharging the static charges and preventing flow of current at normal frequency.

When an electrolytic arrester is being charged, surging currents are set up in the system. Under most

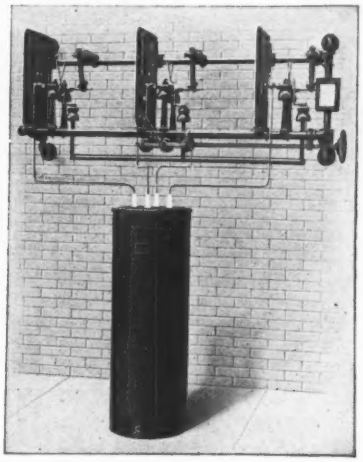


FIG. 1. WESTINGHOUSE TYPE A K ELECTROLYTIC LIGHTNING ARRESTER

conditions these are harmless, due to insulation of the apparatus connected in the same circuit. As above noted, however, there are cases in which these surges are dangerous and in order to remedy this danger, the graphite resistor is used to damp out the surges and limit the charging current to a low and safe value.

This resistor is connected in series between the horn gap and the arrester in each phase. It is shunted, however, by a series of nonarcing metal spark gaps which are auxiliary to the main horn gap. In the operation of charging, the horn gap is short-circuited, as usual, and at the normal voltage of the circuit, the charging current takes the resistance path rather than the shunt auxiliary gap path. On the occasion of a

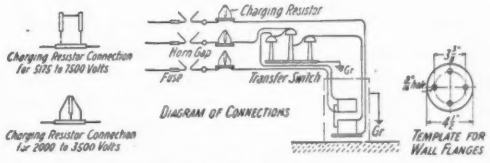


FIG. 2. CONNECTION DIAGRAM FOR ELECTROLYTIC LIGHTNING ARRESTER

discharge due to lightning or static disturbances, the auxiliary spark gap path is easily broken down, and the discharge passes through it, rather than through the resistor, thereby assuring precisely the same freedom of discharge as in the case of an arrester which does not use the charging resistor. Upon the circuit's being restored to normal voltage and frequency after the discharge, the auxiliary spark gaps cannot maintain the circuit and it is shunted to the resistance path. This

action is very materially helped by the use of multiple gaps between nonarcing metal. The resistor limits the amount of dynamic current flowing, and thus helps in the final action of opening the circuit by the rise and final break of the arc on the horn gap.

On each occasion of charging ungrounded neutral arresters to rebuild these films, after once bridging the horn gaps, the leads connecting the 2 middle legs to the ground and to the center fuse, respectively, should be interchanged and the gaps again bridged, thus serving to charge all the "legs" of the arrester. To facilitate this charge, a transfer switch is provided as shown in the illustration. A handwheel is geared to this transfer switch in such a way that the switch can be reversed without the operator in any way coming in contact with live parts, the frame of the arrester being grounded.

Heating Water for Domestic Use

WE have noted with considerable interest the article by Chas. L. Hubbard, in the Feb. 15 issue, under the subject of "Hot Water Supply for Buildings," and trust you will permit us to make a few remarks. The writer has made an extended study of this particular question and finds that there are hardly 2 people who will agree upon the amount of water to allow for the various fixtures, such as baths, showers, faucets, slop sinks, laundry, kitchen, etc. Then again it is true that the nature of the building in which the heater is to be used will have a material effect on the quantity of water to allow per fixture.

It has been our experience that all together too little water is specified for the various fixtures. If a little more leeway were allowed in selecting the first heater, better results would be had.

We trust you will permit us to criticise the article to the extent of those heaters you have described and illustrated. We are not criticising the manufacturers, but we do criticise the use of any heater for this service wherein the steam passes through the tubes. We think you will agree that this is decidedly the wrong principle to adopt. In order to heat a liquid it is desirable to break it up into as small particles as possible, bringing all of these particles into contact with the heating surface.

With the steam tube type, this is accomplished to a very small degree, because the velocity of the water through the heater is very sluggish, the result being that the particles of water lying in immediate contact with the heating surface, must depend upon the principle of convection to replace those hot particles with cold particles of water, and as stated before, this will give a very sluggish flow. Heat transmission depends in a very large measure upon velocity, or the rapidity with which the hot particles are removed from the heating surface and replaced with cold particles. It is for this reason that the water-tube type of heater, if properly designed, is instantaneous in its action and the water is heated as fast as it can be forced through the heater up to the capacity of that heater. It has been definitely demonstrated in many hundreds of installations, that the instantaneous heater is far more suitable for the service than the so-called storage tank heater, which is of the steam tube type. A heater is nothing more than a surface condenser and vice versa, and we are confident that you have never seen a condenser installation wherein the steam is passed through the tubes; invariably the water is passed through the tubes, and there is no possible excuse for any other design being used.

There is but one condition which demands a storage supply, and that condition is in the case where the steam supply is limited, as in a laundry where the only supply of exhaust steam for heating water is from a small engine and possibly from a very small boiler-feed pump. In such a case, water is drawn from the heater but 3 or 4 times an hour, and the demand is quite heavy, in fact, to such an extent that the small amount of exhaust from the engine is not sufficient to take care of the demand for hot water. In this case, of course, it is advisable to store up the heat as it comes from the engine so as to provide an ample supply of water when it is required.

There is no logical excuse in such an instance for using the steam tube heater, as the instantaneous heater should be used in conjunction with a storage tank, one of the objects being to obtain accessibility to the heating surface. For instance, with the steam tube heater, it is a very difficult matter to secure access to the heating surface when necessary to replace one of the tubes or coils. You will readily appreciate this when you refer to a sectional view of any steam tube heater. It is possible that the tubes in any heater made, may split; therefore, accessibility should be given due consideration.—Alberger Heater Co., S. C. Ross.

THERE IS GREAT CONTROVERSY in Congress as to whether the country should encourage the building of American shipping by the granting of subsidies in one form or another. If it will benefit the whole nation, it has reason with it. If the benefit will be to only a wealthy few ship owners, the reason seems lacking. The best argument so far advanced is that the existence of such a merchant marine will increase the sale of American made goods to other countries. In a talk before the Export Association, P. H. W. Ross points out that Germany, by building up such a marine, has increased its exports so that 45 per cent of its manufactures is sold to non-Germans, while the United States sells only 5 per cent of its manufactures to others than its own citizens. He states, also, that if 25 per cent of our manufactures were exported to other countries, our mills could run continuously, the business done would be more profitable and the benefit would extend to all parts of the country. The work was accomplished in Germany by pushing this idea, and the German Marine League now covers all parts of their country and is supported by all classes because they have found that it vitally affects their bread and butter. Recodification and changes in shipping laws are needed, but must come as a result of public opinion. It remains for the public to be convinced that an American Marine will greatly benefit manufacturing in all parts of the country, and this is where study of Germany's experience will prove valuable.

Practical Mathematics

POWERS AND ROOTS IN PROPORTION; COMPOUND PROPORTION; COMPUTATION WITH THE PENCIL AND WITH THE SLIDE RULE

RATIOS can be raised to any power or any root may be extracted, therefore a proportion may be stated so that one of the ratios is between powers or roots. Both terms of the ratio in such problems must be raised to the same power or like roots of both terms must be extracted, as illustrated by the problems that follow.

What is the weight of a lever safety-valve ball, 6 in. in diameter, if a similar ball, 8 in. in diameter, weighs 180 lb.? Spheres vary in weight, as the cubes of their diameters; therefore, we have $6^3 : 8^3 = X : 180$. The first and second terms in a couplet may always be multiplied or divided by the same number, irrespective of any indicated powers or roots, without altering the value of the ratio. Dividing both terms of the first couplet, in the given example, by 2^3, we get $3^3 : 4^3 = X : 180$, or $27 : 64 = X : 180$. $X = 27 \times 180 \div 64 = 75.94$, nearly. To perform the work on the slide rule, place left-hand index of C over 3 on D and above 3 on B find 27 on A, the cube of 3. Place right-hand index of C over 4 on D, and above 4 on B find 4^3, or 64. Now, set 64 on B under 27 on A, and over 180 on B find 75.9 on A.

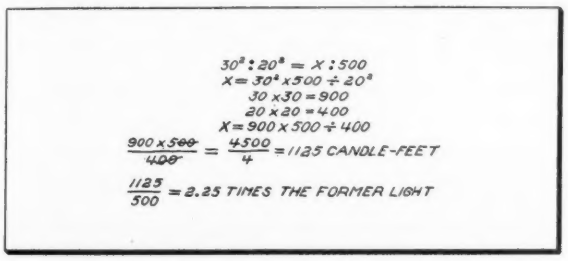


FIG. 1. SOLUTION OF LIGHT INTENSITY PROBLEM

If a safety-valve ball, 8 in. in diameter, weighs 180 lb., what is the diameter of another similar ball which weighs 75.94? As the weights of any 2 spheres are to each other as the cubes of their diameters, we have the proportion $180 : 75.94 = 8^3 : X^3$; the required term, X, must be cubed to correspond with the other term of the couplet, $8^3 = 512$, then $180 : 75.94 = 512 : X^3$. $X^3 = 75.94 \times 512 \div 180 = 216+$, and $X = \sqrt[3]{216} = 6$ in.

The cube of 8 is found, on the slide rule by the method of the previous problem, to be 512. Set 18 on B under 75.9 on A, and over 512 on B find 216 on A. To extract the cube root of 216, place runner over 216 on left-hand A; move slide until the number on B under the runner and that under the right-hand index of C are the same. The latter number, 6, is the cube root.

For cylinders of equal volumes the diameters are inversely to each other, as the square roots of their lengths. A pump cylinder is 12 in. long and 9 in. diameter. For equal volume, a second pump cylinder is 15 in. long; what must be its diameter? $9 : X = \sqrt{15} : \sqrt{12}$. 12 and 15 are not perfect squares, therefore we square all of the terms, giving $81 : X^2 = 15 : 12$. $X^2 = 81 \times 12 \div 15 = 64.8$; $X = \sqrt{64.8} = 8.05$ in., diameter.

The method of solution of the proportion on the slide rule is the same as for previous problems, but after getting 64.8, the square root is to be extracted, and the question is liable to arise whether we use the left or right scale of A in doing so. This can be told from inspection, for it will be evident about the value that the square root of the first period should have; in this case the first period is 64, and its square root is 8, hence, the right-hand scale of A must be used.

An arc lamp illuminates a steam gage 30 ft. distant from it, rather dimly. How much brighter will the gage be illuminated if the lamp is moved to 20 ft. distant?

Intensity of light varies inversely as the square of the distance from its source; therefore, if the intensity of the light 30 ft. distant was 500 candle-feet, we have the proportion: $30^2 : 20^2 = X : 500$. For the arithmetical operations of this problem see Fig. 1.

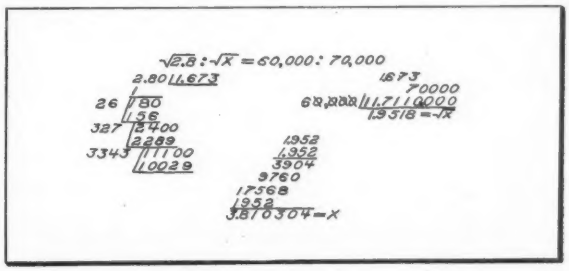


FIG. 2. VARIATION IN FLOW OF AIR BY CHANGING PRESSURE

This problem can be simplified on the slide rule by omitting the assumed candle-feet at 30 ft. distance, and simply taking the ratio of the distances squared, $30^2 : 20^2$. Set 20 on C over 30 on D, and read the answer above 1 on B = 2.25, Ans.

The volume of air flowing through a coal mine varies directly as the square root of the pressure. If 60,000 cu. ft. of air flow a minute when the pressure is 2.8 lb. a square foot, how much will flow when the pressure is 3.6 lb. a square foot?

$$\sqrt{2.8} : \sqrt{3.6} = 60{,}000 : X$$
$$1.673 : 1.897 = 60{,}000 : X$$
$$X = 1.897 \times 60{,}000 \div 1.673 = 68{,}033+ \text{ cu. ft.}$$

On the slide rule we can do this without reading the roots. Set 28 on B under 36 on A and below 6 on C, read 68,000+ on D, which is near enough for practical purposes.

In the problem just completed assume the required volume of air a minute had been 70,000 cu. ft. What pressure would be required to supply this quantity?

$$\sqrt{2.8} : \sqrt{X} = 60{,}000 : 70{,}000$$
$$\sqrt{X} = \sqrt{2.8} \times 70{,}000 \div 60{,}000$$

The arithmetical work is shown in Fig. 2. On the rule, set runner to 2.8 on scale A, and set 6 on C under the runner; this divides the square root of 2.8 by 60,000.

Bring the runner to 7 on C, which would give $\sqrt{X}$ on D under the runner; on A under the runner read the square of this, 3.81 lb.

Cause and Effect

Aside from the relations of magnitude, the terms of proportion have the relations of cause and effect also, and in every proportion problem may be considered as a comparison of 2 causes and 2 effects. For example, if 4 tons of anthracite coal, as a cause, will bring, when sold, $12, as an effect, 12 tons as a cause, will bring $36 as an effect. Since like causes produce like effects, the ratio of 2 like causes equals the ratio of 2 like effects; therefore, 1st cause : 2nd cause = 1st effect : 2nd effect.

If 8 coal passers earn $72 in one week, how much will 15 coal passers earn at the same rate in the same time?

An effect is required in this problem. The first cause is 8 men, the second cause 15 men, and being like causes

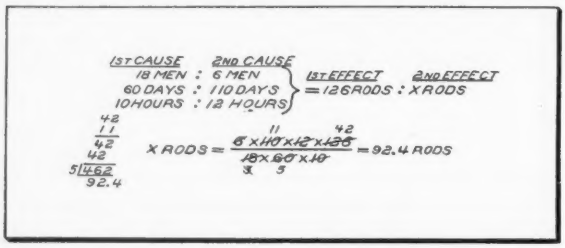


FIG. 3. PROBLEM IN COMPOUND PROPORTION

they can be compared. The effect of the first cause is $72 earned; the effect of the second cause is $X earned, or the required term. Since like effects have the same ratio as their causes, the causes may form the first couplet, and the effects the second couplet of the proportion.

$$8 \text{ men} : 15 \text{ men} = \$72 : \$X$$

$$X = 15 \times 72 \div 8 = \$135$$

If 8 yd. of sheet packing cost $3, how many yards can be bought for $75.

$$8 : X = \$3 : \$75$$

$$X = 8 \times 75 \div 3 = 200 \text{ yd.}$$

Compound Proportions

An expression of equality between 2 ratios, one or both of which are compound, constitutes a compound proportion; in such problems all of the terms appear in couplets, with the exception of one, and this is always the same unit value as the required term. The order of the ratios, and of the terms composing the ratios, is the same as in simple proportion.

Further, if we regard the conditions of each problem as the comparison of 2 causes and 2 effects, the compound proportion will consist of 2 ratios, one or both of which may be compound, and the required term will be either a simple cause or effect, or a single element of a compound cause or effect.

If 18 men can build 126 rd. of railroad siding into a power plant in 60 days, working 10 hr. a day, how many rods will 6 men build in 110 days, working 12 hr. a day? The statement and operations of this problem are shown in Fig. 3.

All of the terms in this problem appear in couplets, except 126 rd., which is of the same unit value as the required term, and is made the third term of the proportion, and X rods the fourth term. The required number of rods depends upon 3 conditions: The number of men employed; the number of days they work, and the number of hours they work each day. Consider each condition separately, and arrange the terms of the same unit value in couplets, and make the statement as in simple proportion, then find the required term in the usual manner. For solving such problems by arithmetic, cancellation materially shortens the operation.

The volume of a cylinder varies directly as its length, and directly as the square of its diameter. If the volume of a gas-engine cylinder, 10 in. in diameter and 20 in. long, is 1,570.8 cu. in., what is the volume of another gas engine cylinder, 16 in. in diameter and 24 in. long? Figure 4 shows the solution of this problem.

To solve on the slide rule, first set 1 on C over 16 on D, thus dividing 16^2 by 10^2 on the upper scales. Move the runner to 24 on B, so as to multiply by 24, and

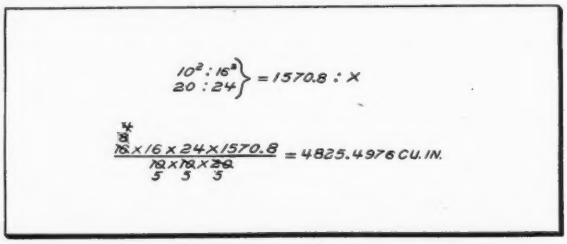


FIG. 4. SOLUTION OF CYLINDER VOLUME PROBLEM

move the slide so that 20 on B comes under the runner. Move runner to 1570.8 on B and read 4,825+ on A, Ans.

Problems for Practice

In order to gain self reliance in performing mathematical problems, it is essential that the student practice making a correct statement of operations and then solve without help. The following examples are given for practice, with the correct answers appended, but without showing the operations.

(1.) If a piece of iron, 7 ft. long, 4 in. wide and 6 in. thick, weighs 600 lb., how much will a piece of iron weigh that is 16 ft. long, 8 in. wide and 4 in. thick? Ans., 1,828+ lb.

(2.) If 24 men can excavate a trench for a power plant, 72 rods long, 6 ft. wide and 5 ft. deep, in 60 days of 10 hr. each, how many days will it take 32 men to dig a trench 96 rods long, 4 ft. wide and 8 ft. deep, working 8 hr. a day? Ans., 80 days.

(Note that 32 men would do the work in less time than 24 men, and that working 8 hr. a day will take more time than 10 hr. a day.)

(3.) The horsepower of an engine varies as the mean effective pressure, as the piston speed and as the square of the diameter of the cylinder. If an engine having a cylinder 14 in. in diameter, develops 112 hp. when the mean effective pressure is 48 lb. a square inch, and the piston speed is 500 ft. a minute, what horsepower will another engine develop if the cylinder is 16 in. in diameter, piston speed 600 ft. a minute and the mean effective pressure is 56 lb. a square inch? Ans., 204.8 hp.

Correspondence of An Old Engineer And His Son

THE VALUE OF THINKING

MY DEAR SON DONALD:—

I suppose that you have been looking patiently for an answer to your letter of several weeks ago; but, as a matter of fact, I have not been at all well, of late. I guess it must be the weather.

You know it is human nature to blame everything on something or someone, and as the weather is the handiest thing, and is the usual thing in such cases, we will blame it on the weather and let it go at that.

Of course I am not young any more, of which fact you are perhaps well aware, and every time the wind changes I feel it. In fact, I can almost read the barometer in tenths of an inch by the intensity of the aches in my joints.

I suppose that you, also, have been busy or you would have written. I realize, Donny, that as one grows older, the inclination to write does not grow any the less, but the opportunity to do so does. There are so many things that, while they do not require any real physical attention, do require considerable concentrated thought in order to secure desired results.

Now, son, speaking of thought reminds me that there is more to thinking than "thinking" people realize. How often do you encounter men who have the mistaken idea that a thoughtful pose and a stern and apparently concentrated expression, constitute the art of thought.

Did you ever see 2 men in the shop get together and talk over some little job? Often it is the boss and a lathe hand. The boss screws up his brow, looks wise, and gives instructions in a way that conveys the idea of originality, and the lathe hand accepts it in the same manner, each making the other believe that he is a wonderful thinker.

Someone has said that 99 persons out of every 100 think just as a toad hops. It hops, and hops, and hops, —and hops,—and hops,—any place, so long as it keeps on hopping. No definite place to go to and no particular direction to take. It hops a while in one direction, and if diverted sideways, or even in the opposite direction, will keep on hopping just as cheerfully and industriously as ever; but it gets no place.

Thinking is the intelligent application of the mind to any given idea, or object, with the intention of uncovering some hitherto unknown fact or facts. Now, Donny, put this into practice and see if it is not so.

Suppose that some one thing about the power house, for instance, becomes disarranged, so that it requires concentrated attention; what do you do? You put your whole mind upon it and try to uncover facts as to why thus and so is the case, or what effect this or that action will have, or whether it will be the right or the wrong thing to do at this time.

You think over first, usually, what the effect is, and then what the cause of this effect is, then what the remedy must be and what to do to secure these desired results. Here is where one must show that he is not like the toad; he must have a certain destination in view.

Let us take, for instance, the machine designer who is engaged in designing a certain engine to meet certain special requirements which are somewhat different from all others, so much so that there is little if any precedent to go by.

Let us presume that it is for a mine hoist, where the mine is of great depth and the loads heavy. The maximum loads are first figured out, over and above the counterbalance, which may be a dead weight or another cage similar to the first one.

The time that is required to hoist this weight from a given depth in a given time is worked out, the friction losses calculated, the reduction gears designed, the additional strength of the cable as it is unwound from the drum, are all to be taken into consideration.

This all works back to foot pounds, and here is where the master thinking mind is displayed, concentrating the mind upon the matter at hand, thinking it out so that, when completed, the maximum efficiency for that particular case will have been attained at a minimum of expense.

Any one can "cut and fit," and keep at it and secure some sort of a result, more or less satisfactory, if time and money hold out; but it requires intelligent application of the mind with the intention of bringing to light some hitherto unknown facts as applied to this particular case, to secure the results that count.

This is the kind of thinking mind that is required where one is called upon almost continually to design something special to do something in a different way.

I believe I told you once that "any fool can improve, but it takes a genius to originate." This all goes to prove that if one learns the fine art of thinking correctly and rapidly, he is in a way of acquiring a substantial financial reward. In this class, there are more positions than there are applicants to fill them, for the supply is limited.

Now, son, why is the supply of thinkers limited, with all of the good literature we have today on practically every subject under the sun? For the reason that so many persons have not learned how to think definitely and to a given purpose.

How to learn? Well, that is the natural inquiry. Here is where the turn of the hand makes success or failure. To be sure, one cannot learn how to think correctly in a few weeks or months, any more than he can become a doctor, or a lawyer, or a mechanical engineer, in the same length of time, by studying a little physiology, a little Blackstone, or a little elementary philosophy.

This is the day of specialism, and men (and women, too) are specializing on some one thing and concentrating the mind on it in order to learn as much as possible about it, in preference to learning a little about a number of disconnected things.

There are various stages of this concentration, just the same as there are various stages of anything else, good or bad, and the degree of success is in direct proportion to the degree of concentration. Somehow or

other, it seems to be the hardest thing in the world for the average young man to acquire the necessary stick-to-it-iveness, that bulldog grip and determination that knows no defeat and that is satisfied with nothing short of complete success.

It is the easiest thing in the world to get discouraged. Just look around for yourself and see. Get a young man to do a certain work in a shop and see how long it will be before he gets lax and disinterested. It is hard to learn to do things by concentration without lapsing into routine.

It is safe to say, that there is no class of work, but what can be made better, easier, and cheaper, by a little intelligent thought, and who is going to do this thinking? Can the foreman? He has many others to whom must be assigned work and who need constant looking after to keep the quality up. Can the superintendent? He has so many different problems that require attention that he cannot neglect others for the benefit of any one of them. It is too far away from the designer, or others who might trim off a corner or two. Well, who will do it, then? Why, the man on the job. He is the one that has the golden opportunity and the one who is in the best position to do the work. He has all of the details under his hand and eye and can become best informed if he will but apply his mind.

But, as a rule, it cannot be done. His mind is usually some place else than on the job. All too frequently it is so dulled by the nerve-racking "coffin-nail," that there is no "ginger" left to force concentration.

A little instance comes to mind at this time that will do to close with. A number of years ago, there were born near us 2 boys at about the same time, and you will perhaps guess their names. Both were bright and intelligent and had every opportunity to succeed, attending the same school, fishing in the same brook and swimming in the same swimming hole when out of school.

Both did well at school, and both succeeded (as the term is generally used); but one had the happy faculty of cultivating deep study and concentration of mind, a mastering mind, while the other did not. Thus it is today that while Fred is making possibly not to exceed $125 a month, "Bill," as he is still called, is getting $10,000 a year.

The same power of concentration of mind and thought which he cultivated 20 yr. ago is bringing results now, and when he turns out a set of blueprints for a new machine, everything fits because everything is THOUGHT out beforehand, and nothing left to chance, to "Oh, that will come all right, I guess."

Well, son, here I have written a lot and I guess I didn't say very much, after all. It appears to me, from away out here, that you ought to begin to find out by this time whether Hazel can make bread like mother used to make. If so, and you can make more "dough" than father used to make, you will get along.

Mother wants to be remembered. Affectionately,

Your father,

SANDY MACDOUGAL.

Towing Locomotives for Panama Canal

THE first lot of electric towing locomotives for hauling vessels through the locks of the Panama Canal are now being received at the Isthmus. In all 40 of these "electric mules" are being built by the General Electric Co. for this purpose. The machines weigh 82,500 lb.; measure 32 ft. 2½ in. long by 8 ft. wide by 9 ft. 3 in., the greatest height over the cabs; have an available tractive effort as high as 47,500 lb. and a windlass rope pull of 25,000 lb.; 4 of them, 2 on each side, will ordinarily propel steamships through the locks. Sometimes 6 engines will be needed to handle extra large vessels; in every case, 2 astern, acting as a brake on the ship's movements, will give direction to her course. No vessel will be allowed to enter the locks and go through on her own power.

The locomotive is propelled by means of a rack rail while towing and while going up or down the steep grades from one level to another at a speed of 2 m.p.hr. While running idle or on return tracks, the speed is changed to 5 m.p.hr. and the machine is propelled by the regular traction method, the rack pinion being entirely released. This change is effected by manually-operated clutches located in the gear mechanism in connection with a lever in each cab similar to a steam locomotive.

Two 75-hp. totally enclosed motors of the mill type, drive the locomotive, one being direct-connected through reduction gearing to each axle. Three-phase, 25-cycle, 220-volt current is used and is collected by contact plows. The motor and traction gearing is mounted on a common baseplate, which in turn is mounted on a driving axle and spring suspended to the locomotive frame the same as in regular railway practice.

In the center of the locomotive is located a vertical windlass with drum, the capacity of which is 800 ft. of 1-in. steel hawser cable. The windlass with its driving motors and gearing is mounted on a solid baseplate and is likewise independent of the movement of the locomotive frame. The cable drum extends above the locomotive cover and has a floating guard placed around it to retain the cable while coiling loose.

The windlass cable is handled by 2 20-hp. motors, also totally enclosed and of the mill type. One is geared for a rope speed of 12 ft. per minute at a pull up to 25,000 lb. at 2 ft. radius, and its function is to adjust the position of the ship for anchor or while being towed through the locks. The other motor is geared for a rope speed of 200 ft. per min. at 2 ft. radius, and its duty is to take up slack or pay out cable or wind in any part of the entire length of cable as may be required.

THE ANNUAL CONVENTION of the New England States Association of Stationary Engineers will be held in Providence, R. I., July 8 to 11. Adjacent to the Engineers' Convention Hall, an exhibit of power-plant machinery, accessories and supplies will be held in Infantry Hall, under the auspices of the New England Association of Commercial Engineers. Full particulars in regard to exhibit spaces, prices and conditions can be had from Herbert E. Stone, Secretary, 53 Equitable Bldg., Boston, Mass.

Foreign Development in the Power Plant Field

TRANSPORTING BOILERS; AIR FRICTION ON FLYWHEEL. BY J. H. BLAKEY

SOME time ago, the Normand Boiler Works at Havre constructed some heavy boilers for the cargo boat, Amiral-Hamelin. Each one of them weighed 45 tons. Transport by land would have been difficult and costly, so it was decided to make a kind of raft of barrels around them and tow them by sea. First, a cradle was built under them exactly as is done in building a ship, and they were launched into the water.

After being towed to their destination, it was a simple matter to hoist them on the ship, as the barrels raised them sufficiently above the water to enable the workmen

FIG. 1. LAUNCHING THE BOILER

to pass chains under them without any difficulty. The photographs show the launching of the boilers and their position in the water while being towed.

RESISTANCE OF AIR TO THE ARMS OF FLYWHEELS

WHEN THE flywheel of a steam engine turns in the air, its arms produce eddies or air currents, and impress upon the particles of air drawn in a centrifugal displacement; these movements result, necessarily, in a loss of energy. They can be prevented, in great part at least, by filling the spaces between the arms by means of smooth, flush panels.

In Zeits. Des Ver. Deutsch, Ingen, M. Heinrich gives an account of experiments made at the Stuttgart Technical School on the principal steam engine in the laboratory, to determine the value of the losses resulting from the putting in movement of the air by the flywheel. This steam engine had been made intentionally so that its flywheel could be run with arms masked or unmasked. It was run without load at speeds of 90, 110 and 130 r.p.m., diagrams being taken every 10 min.

With the arms masked by flush panels, the consumption of power was 5 to 8 hp., according to speed; with the arms uncovered, the consumption was 6.6 to 12.34 hp. —an increase of 20 to 50 per cent.

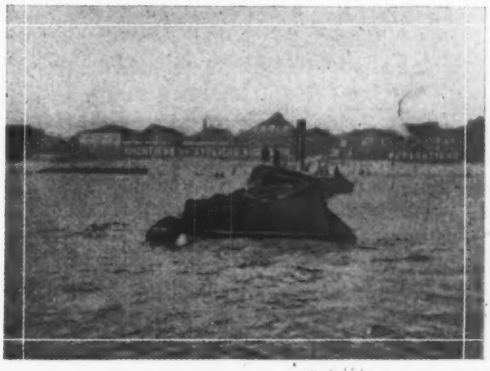


FIG. 2. BOILER BEING TOWED

The author gives the following formula for the calculation of the horsepower saved by masking the arms of the flywheel with panels which are smooth and flush:

$$E=2\left(\frac{n}{100}\right)^3$$

in which n is the r.p.m. Another formula is:

$$E=19\left(\frac{v}{100}\right)^3 dp$$

in which v represents the tangential speed of the wheel in meters per second, d the interior diameter of the wheel, in meters, and p the specific weight of the air in kilograms per cubic meter.

HOW TO UTILIZE the waste heat from the sun for developing power is a question which periodically attracts the loquacity of "Sunday Magazine" writers. It is a fascinating field of conjecture, and progress in it has not yet gone far enough to produce facts which might hamper the imagination.

Frank Shuman has done much experimenting along the line of making low-pressure steam by absorption of the sun's rays, and states that last year he turned 57 per cent of the heat into steam. He estimates that 75 per cent can be utilized by experiment and improvement; and that by covering 20,000 or so square miles in the Sahara Desert with absorbers, the power generated would be 270,000,000 hp., at an investment of some $99,000,000,000. This, he figures, would supply as much power as all the fuel mined in 1909.

But the fuel consumption has increased rapidly since then. And what could we do with that amount of power in Sahara Desert, anyway? And where would the water come from to operate such an installation? And—oh, well! what's the use of arguing? Water power will all be developed long before we shall turn to sun power, and where the sun is really effective as a source,—down near the equator,—nobody wants to work, anyhow.

LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

Substitute for Large Valve

As our office building is situated near the river, the engine room is below the high water line during unusually high floods. For such occasions we have a large steam pump to pump out the water that gets into the engine room. This pump is also used as an emergency elevator pump.

Before I took charge of the engine room the former engineer used to keep the 7-in. flood pipe, which is about 75 ft. long, piled up in a corner of the basement, and whenever they expected a flood, the pipe was laid on sawhorses and coupled up from the pump to the street. After my first experience of coupling the pipe up in a hurry, I decided on a permanent way of locating the pipe so that it would not have to be taken down.

I ran the pipe up from the pump to near the ceiling and put it in hangers, leaving the street end so that it was only necessary to take out a plug and screw in a short nipple to use the pump on flood water.

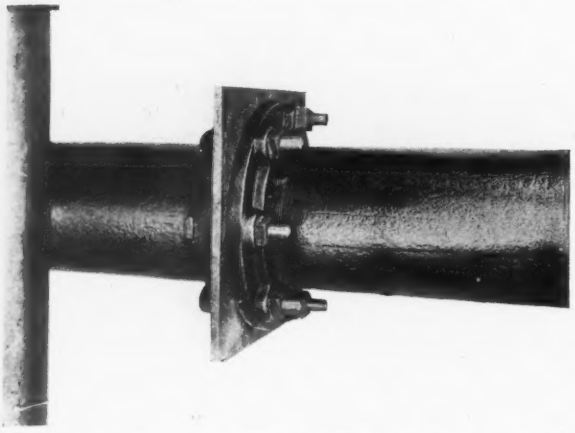


FIG. 1. BLANK PLATE USED IN DISCHARGE LINE IN PLACE OF A VALVE

As the pump was sometimes used for the elevator service, and as we had no valves on the suction or discharge lines, it was necessary to uncouple the flanges and bolt on plugged flanges, this making a lot of extra work; as the company could not see the price of 2 large valves, one 7 in. and one 8 in., I hit upon the scheme as shown in Fig. 1 to take the place of valves. As the flood line is used only once a year at the most, and sometimes not in several years, this plan does very well.

For the suction line I had a blank piece of thin iron cut so that it would fit inside the flange bolts with a handle on it. To put this in or take it out required only to loosen up the flange and take out 3 bolts, pull out the blank and tighten the bolts again. On the pressure side, or discharge line, I had a piece of ½-in. boiler plate, drilled to fit the flange bolt holes. To remove this plate, all the bolts but one were taken out and the plate swung down; the other bolts were then put back in to guide the pipe and then the plate dropped out and the flange pulled together. The pipe was hung so that it had sufficient swing to let out the plate and then come together again.

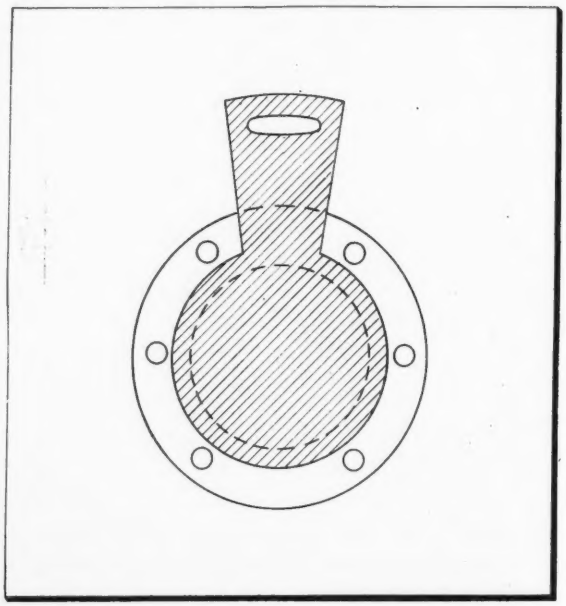


FIG. 2. BLANK USED IN THE SUCTION LINE

L. M. Johnson.

Repairing Babcock & Wilcox Boilers

In the Feb. 1 issue I read A. G. Solomon's article on cleaning and repairing B. and W. boilers and am in perfect harmony with his statements with the exception of one detail. The article states that, if a tube has to be removed on account of a blister or bag and is in such a position that it cannot be reached with a pipe cutter, a number of tubes will have to be cut and taken out in order to reach the defective one. When we have to pay $10 or $12 to have one tube renewed, it would be a very expensive repair item for one tube if it happened to be in the fifth row, since it would cause an additional cost of $40 to $48 over one tube renewed in the bottom row.

The error lies in the fact that it is not necessary to remove any tube other than the defective one, which can be taken out without the aid of a pipe cutter by any

good boilermaker that follows the usual procedure of cutting and bending in at the headers, and pulling the tube through a hand-hole until the bulky part fetches up against the tube hole. Then cut off to a convenient length so that a strap can be hitched on, split the tube to and beyond the header by use of a long ripping chisel, now hitch on your strap and use a tackle to pull out the tube, which will be crowded in as it comes in contact with the tube hole. If you have not ripped it beyond the bulky section, repeat the operation. This same process has to be resorted to sometimes on fire-tube boilers where scale which is thick and hard is adhering to the tubes.

JOHN POWERS.

Trouble With Boiler Flues

INFORMATION given by J. E., under this heading, in Practical Engineer for April 1, is slightly confusing, inasmuch as he says the stay bolts of a return-tubular boiler were badly warped and stretched about 2½ in. I think he must mean braces, as stay bolts are seldom more than 9 in. long. The accumulation of 1/32 or 1/16 in. of scale is hardly sufficient to cause the burning of the tube sheet at the back end under ordinary operation. It would require much more than 1/16 in. of scale on the back head to cause such leaking as he mentions.

I have operated boilers where the tubes were plugged up almost solid between them with hard scale, but the only sign of ill effect was the burning of the rivets in the girth seam over the fire and the cracking of the plate from the rivet hole to the edge of the plate. The plate did not bag down, as was the case in another plant, where the boiler was found to contain about ⅛ in. of scale and about 1 in. of fairly thick mud after the boiler was emptied. The cause, in this case, was neglect to clean the boiler out at the proper time; it had been in constant service for over 3 months, and at times it was forced terribly to keep up the steam pressure on the peak loads. This forcing of the fires is generally believed by the inspectors to have been the technical cause of the bagging of the seam.

As is usually the case with hand firing in power plants, the fireman desiring to be ready for a jump or sudden load, will fill the fire boxes up full of green coal, the coal cokes up and is very near to the bottom of the boiler. Now, if this fire is broken up with a slice bar, it will concentrate a tremendous heat on the shell plate very near or at the girth seam, and this will heat the plate, harden the mud to a scale and burn the plate and seam rivets in a very limited time, until the scale is forced loose from the plate by the action of the excessive heat, which causes it to crack and the water rushes under the scale, cools the plate as the pressure in the boiler forces it downward, making the bag. The loose pieces of scale now come up into the water and if the solvents are used in the boilers, they would be crumbled up to such an extent that, no large pieces being left to tell the tale, it is only theory as to how it could have happened.

J. E. did not say whether or not the boiler was run 24 hr. a day; but this would make no material difference in his case, as he said forced draft was used and no great amount of scale deposit was found on opening the boiler. There is only 1 of 2 other theories to be considered. In the first place, the tube ends, tube sheet and connections of the braces to the boiler head are all badly burned or they would not stretch, and once the tube ends are burned, no amount of rolling, expanding or calking will ever make them stay tight, as the burned metal will not expand or contract the same as the metal of the tube sheet.

There is such a thing as forcing a boiler with forced draft to such an extent that the violent ebullition of the water, in contact with the hot-plate, caused by the rapid evaporation generates steam so rapidly that the water is partially held back from the plate and the plate becomes overheated and burned. But this occurs only in the most extreme cases of forced firing, and with a return-tubular boiler the shell plate over the fire or girth seam is more apt to be burned than the tube ends at the back. For this reason, it appears more like a case of low water under moderate working conditions, while the steam pressure was not up to normal and the boiler had been cooled and refilled either without steam pressure on it or by banking the fire while doing so; for, if the boiler contained enough water to protect the shell plates, it may at the same time have been too low to protect the tube sheet at the rear end. If the top rows of tubes showed signs of leaking first, it was because they were the more severely burned, and the lower ones may also leak an equal amount, being burned in turn as the water lowered in the boiler until it had dropped below the bottom row, when there still was enough water in the shell to protect the bottom portion of the girth seam over the fire if the fire was not forced at that time. I base this theory on the following:

An engineer in a country plant had heard of corrosion destroying boilers and thought that rust occurred on account of the boiler's not being dry when left empty. A new upright boiler was installed in the plant as an auxiliary power supply. After it had been operated about a week, it was shut down and emptied out, as it would not be needed for several months. To dry out the boiler after it was emptied, he took a can holding about a peck of oily waste soaked in paraffin oil, put it in the fire box and lighted it, and dried out the boiler all around the fire box or water leg. When the boiler was started up again, about 6 tubes started to leak soon after the fire was started, then about 12 or 15 began to leak, then all tubes began to leak and the seam below the fire door ring. The fire was put out, all the tubes were expanded and calked 3 times, but still leaked; to make them tight, about 3 qt. of cornmeal were put into the boilers, which tightened them up very well, but the meal had to be put in each time the boiler was started.

In another case, the fire was green, having been cleaned by the night fireman. Since everything was going well in the plant, he proceeded to blow down all of the 5 boilers of the battery, all 6 by 19½-ft. return-tubulars. Coming to the last one, near the chair at the door, which was quite full, he sat down in the chair to watch the water lower in the glass. He evidently

had been drinking some the previous day and fell asleep. When he awoke there was no water in the boiler and, not remembering what he was doing before, he called the engineer, who heard steam blowing through a pipe apparently back of the boilers. This being unusual, he went to the blowoff cock and found it open. Examination showed the tubes at the back to be burned and the boiler bagged.

Another case of this same kind caused the loss of a fusible plug and 2 top rows of tubes, which had to be put in new. If the braces are stretched and buckled, they will have to be replaced with new ones and possibly new tubes will have to be put in; all depends on the condition of the tube sheet. If it is not cracked or seriously burned, which I think it must be, the boiler might be made tight by giving it a feed of bran or meal; but if I were operating it, I should insist on a new tube sheet, as well as new braces. New tubes would then be put in, which would put the boiler in a safe condition for operation. R. A. CULTRA.

Repairs to Steam Pump

AN ENGINEER selected a duplex steam pump to feed his boilers of such size that he could run it at a speed of 40 ft. per min. when the greatest demand for water occurred. Shortly after the installation of this pump, this man took another plant.

The newcomer finding it was impossible to heat the feed water over 130 deg. F. with the amount of exhaust steam from the engine and pump, decided to "improve" matters as he thought, so this is what he did.

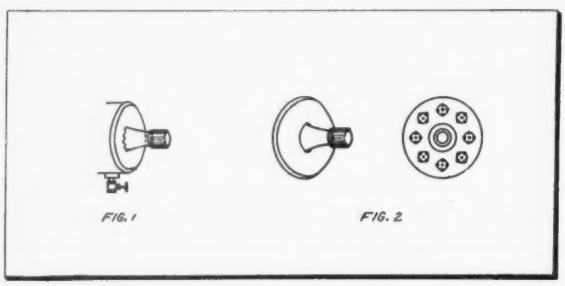


FIG. 1. CRACKED CYLINDER HEAD

FIG. 2. CYLINDER HEAD CASTING AND METHOD OF LAYING OUT BOLT HOLES

The bonnets from the steam chests were removed and the lost motion between the lug on the steam valves and the confining nuts was reduced one-half, the result being that the pump must be run at a higher speed to supply the required feed water and the extra exhaust steam used in the heater. While the temperature of the water was raised, the new man took no account of the amount of coal burnt, so he did not notice the fuel consumption had increased, the extra shoveling he said was due to a lower grade of coal used than formerly.

Another saving scheme was that as feed pumps were of little consequence, they did not require lubrication in the steam cylinder, so he proceeded to run without oil in the steam cylinders.

In a short time the wear in the cylinders and rings was noticeable and one morning the stuffing boxes, which were cast with the front steam cylinder head, were found cracked almost the whole circumference. The pump was sent into the shop for repairs, which were made as follows:

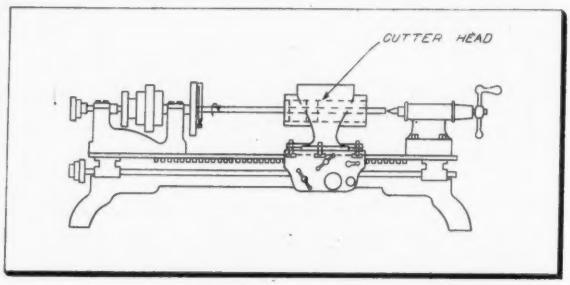


FIG. 3. WATER CYLINDER OF PUMP IN LATHE

As the steam cylinder and frame were one casting, the water cylinders were removed and the casting mounted on the planer. On the surface, where the stuffing box had been planed smooth and reduced in thickness a little, a pattern as shown in Fig. 2 was made and the castings arrived in due time. This casting was trued up in a chuck, and the hole for the rod, and the stuffing box bored out. The side to fit the cylinder head was then planed, and a templet made of the layout of the bolts.

The templet was placed in position on the chalked head and the circles scribed thereon. The centers of these scribed circles were located, and also center punch marks around the circumference of these as guides when drilling the holes. After the holes were drilled and tapped, the piece was leaded and secured with cap screws. The water end was mounted on the lathe carriage as in Fig. 3, after first removing the compound cross feed, the casting being securely strapped to the carriage.

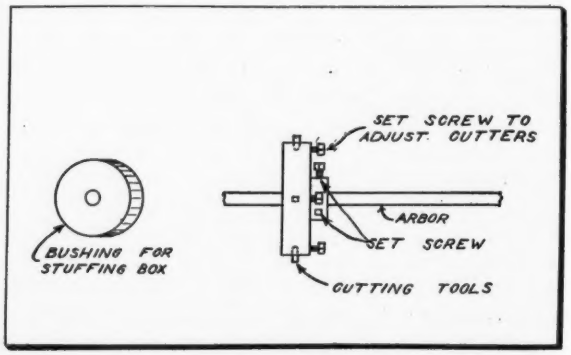


FIG. 4. TOOL HOLDER FOR REBORING CYLINDER

A bushing, the same diameter as the inside diameter of the stuffing box, was turned up and placed in the stuffing box to steady the boring bar.

A casting was turned 1/16 in. smaller than the smallest inside diameter of the water cylinder and secured to the arbor as shown in Fig. 4. Cutters were set in drilled holes on its circumference to take the chip. The arbor was driven by a dog in the face plate and the other end was held by the tail center. The back gears were thrown and the feed adjusted for depth.

Both steam and water cylinders were thus successfully rebored. New rings were made for the steam cylinders.

A ring was made of sheet brass and inserted on the water piston to save time while a new piston was being made. As the piston rods originally were an odd size, a slight skimming up to straighten the rods gave a standard diameter.

When the pump was assembled, the proper amount of lost motion restored to the steam valves and the water end packing carefully adjusted, the pump supplied the water at the original speed.

RECEIVER.

What Constitutes A Chief Engineer?

IN THE issue of March 15, the editorial under this heading is quite to the point in many respects.

The answer is easily obtained by looking about us, for there are various types of chief engineers, and no two alike. Some of the many traits that go to make up one may be decidedly lacking in another, and so on. But the question, "What Constitutes a *Good* Chief Engineer?" is not so easily answered by looking about, trying to find those that measure up to the standard necessary to come under this class. It's true, there are many of them; but they do not come in job lots, by any means.

Generally speaking, the writer considers there are 3 qualifications needed by a man in order to be judged a good chief engineer:

First: He must necessarily be fairly well posted on the various types of power plant machinery. Of course, one man might be well trained in several different types of power plants and have little knowledge of others. Again, he might be a man who rose from the bottom in one plant and knows practically nothing of others, yet would make an ideal chief engineer for this plant.

Second: He should be a man of good, sound judgment, a student of human nature to that degree, where the proper handling of men comes to him almost like a second nature. Without this qualification he will soon become engulfed in difficulties in the operation of the plant, and possibly with the men, that will lead to his discomfiture and ultimate undoing.

Third: He should be a man of tact in his dealings with the office. Many otherwise good men lose out solely from this cause alone. Even though he possesses a wealth of sound and original ideas concerning changes in the plant, new machinery, etc., whereby the cost of power and production may be lessened; if he is unable to present it to the office in a convincing manner (and here is where some of the second qualifications will be of use), he will never be a truly good chief engineer.

In the editorial, mention is made of a certain chief who sent his assistants away when applying the indicator, etc., for fear of losing his position to a subordinate. As said previously, there are several types, and this is one of them, and we find another exactly opposite in the man who practices the saying, "Let George Do It." This type possesses neither a set of tools nor a pair of overalls, as he has no use for them—would not use them if he had them, and could not if he would.

When any job of consequence or an emergency comes along, he is usually busy in a remote part of the plant or at home and tells "George" to look after it. He is the one who says his boilers are in good shape, although he has never been inside of one, but "George" said they were O. K. He is the one who says the governors and valves are set correctly, for "George looked after them" and said they were.

When anything original that amounts to anything is to be devised, or important repairs are to be made, he tells "George to do it." But when anything such as writing an order for a gage glass or a grease cup comes along, he assumes an air of "I Am It."

Of course, a chief engineer is not supposed to assist in all the many repairs, or even have knowledge of them; but where there is a job of any great importance, he should decide himself in what manner it is to be done, and though not taking an active hand in the work, he should at least see the job done.

There is another fault otherwise good engineers have, and that is failing to make a note of supplies, repairs to be made, etc., when informed by their subordinates. Many times they will forget it, which later leads to petty annoyances. When time comes to use the supplies or make repairs, it is found this has not been looked after by the chief. He is apt to say he was not aware of the need of them, while the subordinate will declare he told him of it. A chief engineer should make a note of such, the date, by whom he was informed, etc., thus eliminating all possible chances for disagreements and delays. Especially is this true in a large plant where the chief engineer's duties are many and varied.

JOS. STEWART.

Use of Old Vehicle Batteries in Small Stationary Plants

THE PRINCIPAL reason why storage batteries are not used more in small electric plants is the first high cost of the battery. There is no question but that the storage battery is very useful for handling light and even heavy night loads when it would be expensive to keep the steam or gas engine running or to start such machinery for emergency purposes.

A solution for obtaining suitable storage batteries at lower cost has recently been brought to my attention which may be of interest to many engineers, especially if electric vehicles are considerably used in their locality.

The owner of a small steam electric plant got hold of some vehicle batteries that were "all in" for vehicle

service, so the owner of the vehicles told him. The vehicle man was willing so sell them at their scrap value and the plant owner, believing them to be of further use for stationary work, bought them. He placed the plates in regular stationary battery jars, burned connections, as is done in stationary storage battery work, and wired the outfit into his plant, making the necessary connections for throwing in and out. Current was used at night for lighting and running fans and motors, and the improvised battery did service for more than a year.

As soon as the battery was giving signs of distress, the plant owner bought more vehicle batteries, took out the old plates and substituted the fresh ones. The "old" plates were then sold at the same price for which the fresh supply was bought.

Instructions for burning in, setting up, connecting, charging batteries, etc., can be obtained in the catalogs of almost any manufacturer of storage batteries.

N. G. NEAR.

Engine Foundation in Swampy Ground

A NUMBER of years ago it became necessary for me to install some engines in the swampy lands of Louisiana. My success evidently was the cause of my being asked, by several, for directions for setting up engines on similar unstable grounds, a request which finally caused me to make a few sketches, accompanied with directions, as follows:

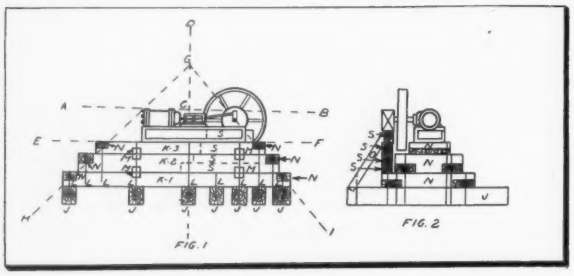


FIG. 1. SIDE VIEW OF TIMBER FOUNDATION
FIG. 2. END VIEW OF FOUNDATION

Make a sketch of the engine on its bed, as is shown herein, then draw a line, AB, along the top of the cylinder, find the exact central point between the back head of the cylinder and the center of the shaft, and draw the line CD.

Measure the distance from C to the back head of the cylinder (toward A); then measure the same distance up the vertical line, CD, making a point of intersection, G; now draw a line from the center of the shaft, to G.

Next, you extend the lines so found from the shaft center and the cylinder head to the point G, which will make the lines GH and GI. You should select your timbers of sufficient length to enable the bottom side of the ends to reach to the lines GI and GH, according to the location they may occupy in the tier. After having secured the timbers of desired length, you halve them at each end, as shown by the letter N.

At 2 points, say directly under the back end of the cylinder, and at the point directly under the other end of the iron bed, you should cut in and fit a square timber as letters M show; this is to prevent the timbers from working in end, when the engine is in operation. At each end there is halved in, a timber shown in both Fig. 1 and Fig. 2. This fitting up of all these joints you may notice is simply cutting in half each timber, as it is work that can be done by common work hands, with a crosscut saw and a chisel, and economy is desirable in the building of a setting for an engine that may not run more than a year in the location where it is being set up.

After all the work has been done with the crosscut saw and chisel, we stack up the timbers, and dig a hole in the ground, in which we place the bed ties, marked J. These ties should be placed deep enough so the top of the timber K1, when in position, would be on a level with the ground surface, the earth should be well tamped under and around the ties, and they should be in line, and perfectly level on top when the timber K1 is placed on it.

Tamp the dirt well all around the timber K1 and then place the end pieces, N, in their respective positions, nailing them at the corners only. Now proceed to place K2 and then K3 in position in the same way, remembering to enter the inside cross pieces, M, as you build up the frame.

Having now completed the piling up of the timbers, you take a ship auger, and bore holes through the top timber, and so on down through all the other timbers until the lower face of the last tie, or timber, is reached, then cut off ordinary round bar iron rods, of correct length for each position to be pinned, and then drive them carefully, driving the 2 opposite ends first, then working in toward the center holes, as this method has the effect of evenly distributing the jar on the ties, and does not tend to settle them unevenly.

These drift bolts are shown by the letter L in Fig. 1 and come flush with the top and bottom of the frame, when in place, as desired.

The iron box bed of the engine should be drift pinned to the top timber, as well as being let into the timber about 2 in., as an additional precaution against end movement after the plant has been operated a while.

Under the shaft and wheel, 2 additional ties should be placed, as shown, to prevent any effect from belt pull, or the motion of the crank toward lowering the foundation on that end, from constant oscillation.

The outboard bearing for the shaft should be supported by blocks, built up beginning on the top of K1 to the desired height, these being both nailed and drift bolted. Put a brace outward, O, gained at top and bottom, and drift bolted at each end; these blockings are shown by the letters S in end in Fig. 2, and on the side in dotted lines in Fig. 1.

The length of the ties should be as great as possible, no timber is acceptable under 12 in. square and it is better 18 in. square. I always tried to get the line EF as much as 3 ft. above the surface of the ground, as it took the driving belt up off the ground, and prevented many accidents.

This timber was generally cypress, which stands well in such places, as it is a water plant, and the nature of the work of building, as is readily seen, required no skilled men. The plans are the result of much meditation, hard work, several disappointments, and the employment of several languages.

WM. T. ANGELL.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Proposed Change in Heating System

FIGURE 1 is the outlay of the present heating system of a hospital. In the power plant are located 2 80-hp. horizontal tubular boilers, tested for 125 lb. pressure. They have a 12-in. opening at the top and are connected to a 12-in. header. From the header, steam is distributed through a 12-in. main for a distance of 150 ft. to the main building; 6 branches are run from the main supply, as indicated, while one is run to another smaller building (known as the old house). Risers are connected and rise to the fifth floor, distributing steam to the radiators on each floor. A separator line is run from header to operating room, which is not indicated in the sketch. The total radiation comprises about 12,000 sq. ft. It is a single pipe gravity return

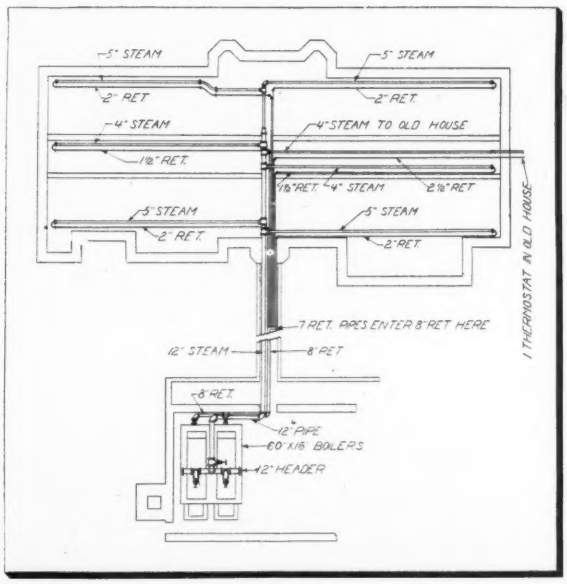


FIG. 1. PLAN OF HEATING SYSTEM IN A HOSPITAL

system. We also have a 40-hp. horizontal tubular boiler for high-pressure steam, which is used one day a week to run the engine for the laundry, and also to furnish steam to the laundry; we can also heat the water with this boiler for the entire building. When the high-pressure boiler is not used, the water is heated by a separate heater.

Under the present system, we are practically running 3 systems. No reserve steam is held in boilers used for heating, the steam going into the system as fast as it is generated, and it is impossible to maintain a uniform pressure on the system; further, it seems to me that too much water is carried through the system when running pressure from 0 to 20 lb. By carrying 90 lb. on the boilers and reducing it to 1 to 5 lb., a drier steam, carrying a higher temperature, would result and, I believe, effect a saving of fuel. Therefore, I would propose to put in a reducing valve, as indicated in Fig. 2, place vacuum traps, or thermostats (either the float or expansion type), at the end of steam mains, place a vacuum pump at the end of the tunnel and connect it in return main. Place a valve between boilers and vacuum pump so boilers could be operated at low pressure in case either pumps failed, by using 4-in. bypass and closing reducing valve.

Run returns from vacuum pump to open heater and use boiler feed pump from heater to boiler. I would propose a complete vacuum system, but the funds available now are not sufficient. We could also run returns direct to a receiver, but when we would change to a complete vacuum system there would be a receiver to throw away, while the thermostats could be left as they

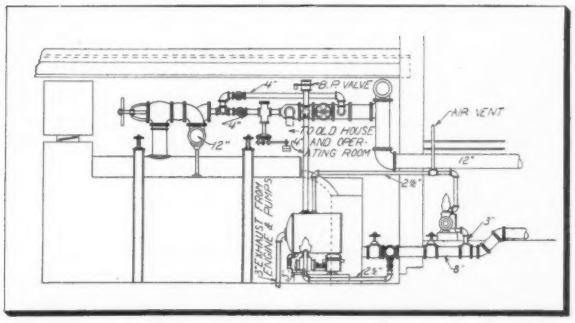


FIG. 2. ELEVATION OF PIPING IN HEATING SYSTEM

were. I would cross-connect operating rooms and old house line to steam main, as indicated in Fig. 2, also to a 2-in. reducing valve (not indicated), so these places could be heated separately if necessary, which frequently happens.

Operating rooms are now connected to low-pressure header and to 2-in. reducing valve to high-pressure header, so either can be used. I would also heat water for the building from the boilers and do away with separate heater.

During summer, when buildings are not heated, the 40-hp. boiler could be used to heat water. I would use exhaust from the engine in the heating system in winter, and for heating water during summer, and use live steam when the engine is not running.

I would be pleased to hear from you as to whether you think there would be any saving of fuel and

whether such a system as I have proposed would be practical. It would have the advantage of leaving the operating room in readiness, day or night. The laundry could be run without firing up extra boiler. No extra heater would be required to heat water. They could sterilize at any time and the heating system would carry a uniform pressure. H. V. B.

A. In this change, there would be needed valves of the vacuum type in the returns from the radiators and coils, because, if they are not put in, the steam would draw through and destroy the vacuum, passing through the nearest radiator direct to the pump. Ordinary globe valves will do, as they may be adjusted and then the wheels taken off so that they would not be disturbed.

With this exception, your scheme seems perfectly feasible, and, as you state, much more convenient on account of steam available for sterilizing at any time.

In the writer's opinion, there is no good reason why a uniform steam pressure should not be maintained now as well as by changing to a high pressure and then reducing. I would recommend a good damper regulator and that the fires be watched closely. It is easy to let the pressure down when running low pressure, because there is no noise and nothing to warn the attendant when the pressure drops; consequently, he is liable to let the fire get a little low and then it takes some time to bring it up again to the proper condition; during that time, the radiators and coils have cooled somewhat and filled with air, which has to be driven out again. Thus, the time lost is nearly double that in which the pressure is down.

I do not see any saving in the proposed arrangement, beyond the fact of shutting down the 40-hp. boiler and possibly by using a more uniform pressure in heating. The system would be more flexible, however, and, by being easier to regulate, some saving could probably be made in moderate weather. For instance, when a small amount of heat was needed, a little steam could be spread over a large space by using a very low pressure in the system, thus distributing your heat better, and it might be that the engine exhaust could be thus spread over the whole building when the engine was running, thus requiring no live steam at all; that is, when the weather is not severe.

The saving would be due, however, to the regulation of the system. To offset this, there would be some loss of heat in carrying high pressure, from radiation and high temperature of flue gases.

The exhaust from the engine and, also, from pumps, if you install them, should by all means be used for heating buildings and water; but you will need to install a good separator in each exhaust pipe before it enters the heating system, although there are good open heaters which are arranged for that purpose, so that no extra separator is needed, all of the exhaust pipes being run to the heater first and then to the heating system.

In regard to heating the water by the boiler, that could be done now by making a connection from the 2 heating boilers to the same heater that you use with the high-pressure boiler, or, if you have no heater, by installing one; but it seems as though it would be more economical to run the separate water heater than to run the boiler for that purpose.

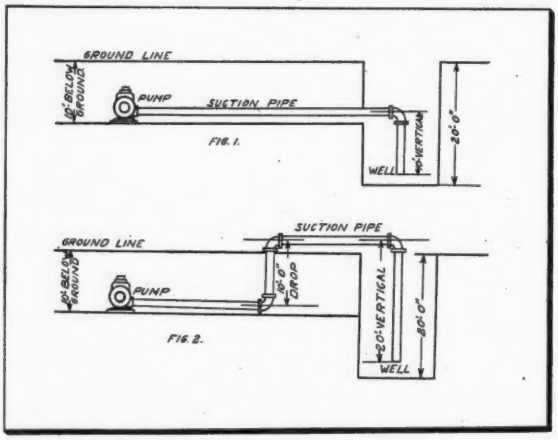
S. E. Balcom.

Mine Haulage Problem; Pump Suction

What horsepower is required to hoist 8 mine cars, loaded with coal, up a slope on about 7 deg. pitch, at a distance of 5000 ft. underground to the surface? The total weight of the 8 cars, loaded with coal, is 40,000 lb., or 20 tons. The dimension of the hoisting engine is as follows: 16-in. cylinder, 20-in. stroke, 100 r.p.m.; boiler pressure is 110 lb.; diameter of the drum on the engine shaft is 4 ft. 3 in. What is the pull on the rope on the drum, and a rule for the calculation? The horsepower of the engine would be greater than the power of the drum, if I understand it right.

We are having some trouble with this engine, from time to time, and I want to find out if the engine is too small for the work.

2. We are going to install a 3-plunger pump, direct connected to an electric motor. The sketch shows the arrangement. We have to install the pump 10 ft. below the surface of the ground in order to get close enough to the supply of water. I want to know the difference between the 2 ways of connecting up the suction pipe.



TWO ARRANGEMENTS OF SUCTION PIPING

How much more friction is on suction pipe in sketch No. 2 than there is on suction pipe in sketch No. 1? Note there is a 10-ft. fall on suction pipe in sketch No. 2, will that make any difference? If it doesn't make any difference which way it is connected, the latter method will save us considerable digging. A. H. M.

A. As to the mine haulage proposition, it is necessary to use, in the solution of this problem, trigonometric tables, the process of which is entirely simple.

The pull on the rope will be equal to the weight hauled, times the sine of the angle of incline. From the tables of trigonometric values, which you can find in any handbook and also in the data sheets of the June 15, 1913, issue, page 623, the sine of 7 deg. is 0.1219. Multiplying 40,000 by this gives 4875 lb. as the pull on the rope of the hoisting drum. The drum is 4¼ ft. in diameter, which gives a circumference of 13.35 ft. It runs at 100 r.p.m., so that the distance traveled in 1 min. is 1335 ft. Multiplying this by the pull and dividing by 33,000, gives 197.4 hp. to pull the load. There will be, of course, some additional power required, because of the friction of the wheels on the axles and on the release.

As to the power developed by the engine, assuming that this cuts off at 5/8 stroke, and has a 9 per cent clearance, the ratio of mean forward pressure to initial pressure will be 0.9262. Multiplying by 125, the absolute pressure, gives 115.8 as the mean forward pressure; and subtracting a back pressure of 15.8 lb., gives 100 lb. as the mean effective pressure.

The length of the stroke in feet is $20 \div 12$; the area for a 16-in. circle is 201 sq. in., and assuming the engine to be double-acting, the working strokes per minute will be 200. We then have, mean effective pressure times length of stroke times area of piston times working strokes per minute divided by 33,000, which gives 203 hp. This is rather small in comparison with horsepower required for pulling the load. The probabilities are that the cutoff is later than 5/8 stroke.

2. As to your pump problem, you do not give us the amount of water to be pumped, or the size of pipe which you will use. Both these are necessary in order to calculate the amount of friction which will be introduced by the extra 20 ft. of pipe and the 5 elbows due to your second method of piping. I assume also that there is some extra horizontal piping not shown by the sketch.

The formulas by which you can figure out this loss will be as follows: The loss of head in feet equals 0.000,004 times length of pipe in feet times the square of the velocity in feet per second divided by the inside diameter of the pipe in feet.

The head in feet loss through a 90 deg. elbow is 0.1513, times the square of the velocity. This must, of course, be multiplied by the number of elbows introduced. The sum of this head loss from the extra pipe plus the head lost through the extra elbow, will give you the actual suction head added by the more complicated method of piping.

The fact of an extra 10-ft. lift, accompanied by a 10-ft. drop, would not affect the action of the pump, so long as the suction pipe is kept full of water. If there were air leaks, this would introduce difficulty in operation. A. L. R.

Packing for Ammonia Rods

How do you think a packing made up of cork and asbestos, lubricated with graphite and ammonia special nonfreezing oil, would turn out?

I am an engineer of a building and our ammonia system is a Lindey Canadian. It is rated as a 35-ton machine, and as we always have ice on hand, we need to run the compressor only about 10 hr. a day. We carry around 125 lb. pressure on high pressure side and the expansion returns around 15 lb. We have quite a little trouble to keep a packing in more than 6 or 7 weeks. The cylinder of the compressor is 10 by 21 in. I would appreciate your views of a good packing on the market. T. H.

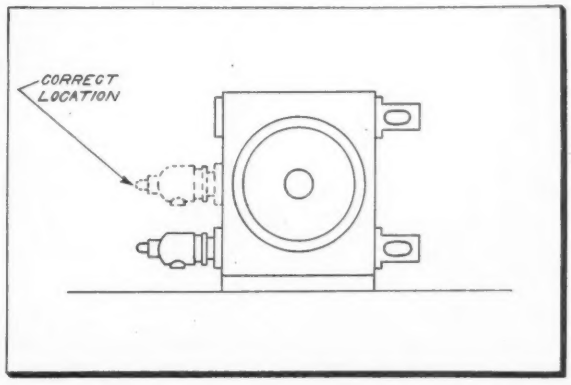
A. We do not believe a packing made up of cork and asbestos would be suitable for packing ammonia rods. The Lindey ice machine, made by the Fred Wolf Co., of Chicago, when sent out from the factory is packed with pure gum rings with a metal ring between every second one. This packing lasts from 1 to 3 seasons when properly lubricated and taken care of. Good results on any ammonia rod may be obtained by using almost any good fibrous packing, which will give good results if properly handled. It is customary when closing down the machine to tighten up the packing on rod to prevent leakage, while the engine is standing still. On starting up, the packing should be slacked up to prevent getting hot and possibly burning. From this cause alone, a great many sets of packing are ruined, which otherwise would give good results. Also, when the machine is in operation care should be taken not to let the compressor freeze back too heavy. The piston rod and discharge valves should be kept comfortably warm at all times on the Lindey machine. If these precautions are carried out, there is no reason why a set of packing should not last you at least one season, providing your piston rod is in line and not scored.

Relief Valves

In reply to I. X.'s question in regard to the proper size of relief valve to provide for a given size of cylinder, I offer the following.

Different builders provide different size valves for the same size cylinder and, as far as I know, there is no rule to determine the size, the builder using his judgment in the matter.

While, no doubt, many wrecks have been averted because of the relief from water afforded by the relief



PROPER AND IMPROPER LOCATION OF RELIEF VALVE ON ENGINE CYLINDER

valves, the primary object of such valves is to give warning to the attendant that a dangerous condition exists and to take such steps to remove it as circumstances require.

When relief valves are provided, they should be located in the clearance space and not in the back bonnet of the valve chambers, as in the diagram, where they are practically of no use whatever.

I advise I. X. to seek the cause of water entering the cylinder and remove it, and not depend upon relief valves to protect his engine. Receiver.

Brattleboro, Vt., persons have incorporated in Vermont the Croydon Development Co., capital stock $200,000, for water power work in Sullivan County.

Problems For Discussion By Readers

What Would You Do If You Had These Conditions To Meet?

Answers to Massachussetts Examination Questions

THE FOLLOWING is submitted as answers to the questions by R. H. B., on page 318 of the March 1 issue.

1 & 2. It is necessary to consider the water leg carefully when determining the strength of the Manning boiler, such water leg being subjected to a collapsing strain.

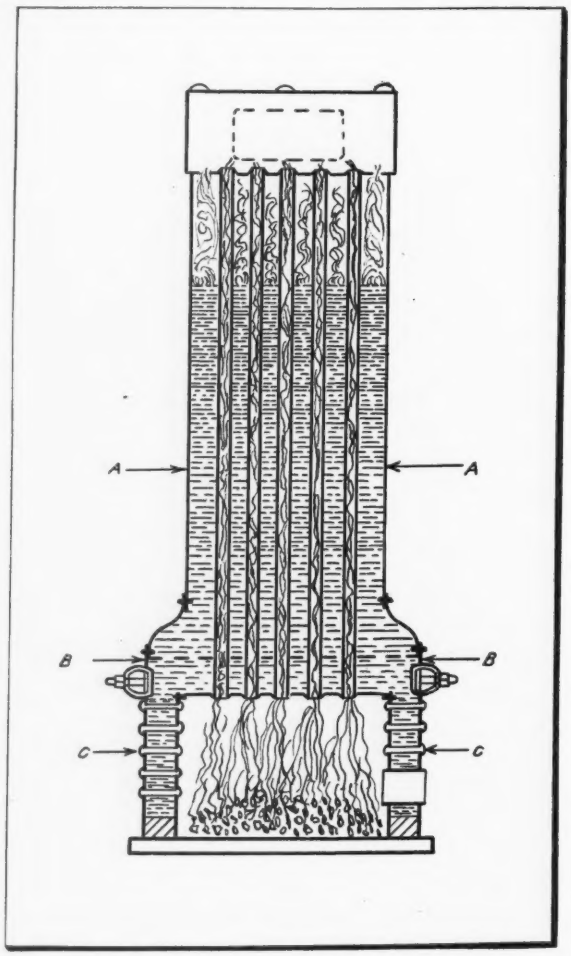


FIG. 1. VERTICAL SECTION OF MANNING BOILER

For illustration, we will assume a Manning boiler, Fig. 1; diameter of barrel 76 in., outside diameter of furnace 92 in., inside diameter of furnace 84 in.; thickness of plate in barrel 17/32 in.; outside furnace sheet ½ in.; inside sheet 7/16 in.; heads 9/16 in.; staybolts ⅞ in.; diameter of pitch 7 in. on centers. As the inside furnace sheet is always thinner than the other plates, our calculations for the strength of the firebox will be based on this sheet.

The United States Government rule for stayed sheets is, for plates 7/16 in. or less in thickness,—multiply the square of plate thickness in sixteenths of an inch by the constant, ½, and divide by square of pitch of staybolts. Plates over 7/16 in. thick, constant becomes 120. In the assumed case, the inside sheet is 7/16 in. thick. The square of the thickness in sixteenths is $7 \times 7 = 49$; $49 \times$ constant $112 = 5488$ lb. This divided by the square of the pitch of the staybolts, 7 in. $= 49$; $5488 \div 49 = 112$ lb.

Safe pressure for the barrel, as A A, is found from the usual formula for cylinders: $SP = \frac{TSt\%}{RFS}$.

TS = tensile strength.
t = plate thickness.
% = efficiency of joint.
R = radius or ½ diameter.
FS = factor of safety.

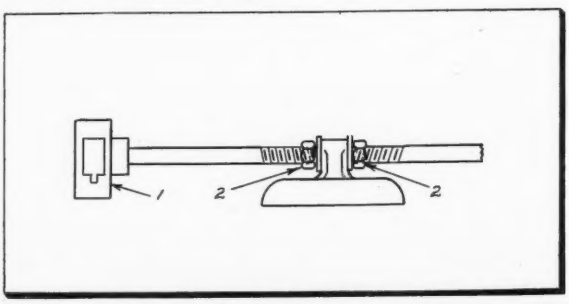


FIG. 2. METHOD OF HOLDING VALVE TO STEM IN GREEN ENGINE.

Plate thickness $(17/32 = 0.531{,}25) \times 60{,}000$, tensile strength, times 0.86, the efficiency of joint, divided by 38, ½ the diameter, and divided by 5, the factor of safety, = 149 lb., the safe pressure.

Safe pressure figured on the portion BB between the barrel and water leg staybolts is figured the same way.

We have outside sheet 0.5 in. thick; $0.5 \times 60{,}000 \times 0.86 \div (46 \times 5) = 112$, and as this is the lowest of the 3, it is the safe pressure.

3. Butt strap joints are preferable, because when correctly proportioned they are the strongest form of joint, and also they do not distort the plate from a true circle and afford a better chance to calk the seams.

4. If we assume a plate 0.5 in. thick, with staybolts 0.875 in. diameter at bottom of thread, pitched 6.5 in. in centers, we can use the United States rule previously given. The example worked out appears like this:—Square of plate thickness in sixteenths (5×5)

$= 25 \times 120$, constant $= 3000$; square of pitch, $6.5 = 42.25$; $3000 \div 42.25 = 71$ lb., safe pressure.

We may use a smaller pitch for the staybolts and gain a slightly higher pressure.

5. In a well proportioned joint, the strength of the sheet between the outer row of rivets and the strength of the rivets are as near equal as possible. Generally the strength of the plate between the outer row of rivets is the weakest.

6. If one is familiar with boiler construction, he can generally tell whether the correct size rivets is used, just as one can tell the diameter of a pipe.

7. The only pump on a condenser that should be termed a vacuum pump is the dry vacuum pump. As the air and noncondensable gases rise, the suction of this pump should be connected to the highest point of the condensing chamber, to be most effective.

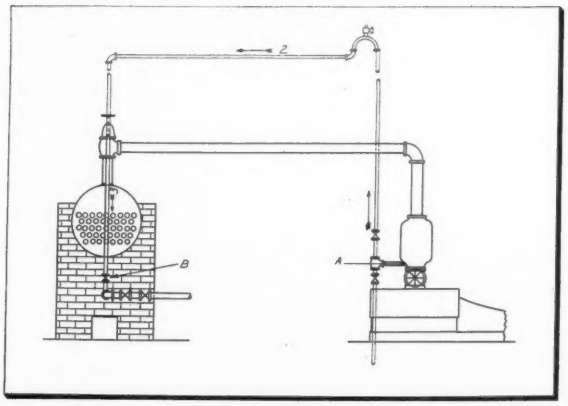


FIG. 3. STEAM LOOP CONDENSATION RETURN SYSTEM

8. As a perfect vacuum is impossible of attainment, even with the best of apparatus, from the fact that it is impossible to remove all of the air, if the gage showed 30 in., we should know the gage was "out." The indication of a vacuum gage shows to what extent the atmospheric pressure has been reduced, and what absolute pressure exists. If a gage showed 26 in., taking it that each 2 in. of vacuum equals 1 lb. pressure, $26 \div 2 = 13$ lb. of the atmospheric pressure removed. As the atmospheric pressure is 15 lb. at sea level, $15 - 13 = 2$ lb. absolute in condenser.

9. The valves of the Green engine, of which the writer has had charge, were held to the stem as shown in Fig. 2. The stems cannot unscrew from the valves, but the nuts, 2 2, have been found moved from the lug on the back of the valve. Also, the stem has backed out the sliding block, 1, where it was held by a bolt and setscrew.

10. The steam loop is a good way to return condensation to the boiler.

Its operation is as follows:—When water collects at the lowest point, as A, it shuts off temporarily the supply of steam from the separator connection, and the check valve, B, at the boiler keeps the pressure from acting in that direction. The result is, the horizontal, pipe 2, is entirely shut off from boiler pressure and the condensation in it soon reduces the pressure in it. Immediately the pressure in front of the slug of water at A is reduced, the pressure in the separator forces the slug up and down into the horizontal into the drop leg, 3. The steam entering behind it restores the pressure once more and when the water stands at such a height in the drop leg as to overcome the resistance of the pipe and check valve, it passes into the boiler by gravity. It is generally connected into the blowoff pipe, cannot be connected into pump line.

11. The formula, $\frac{4H^2}{3} \sqrt{\frac{2R}{H}} - 0.608$, is universally conceded to be as accurate as any to find the area of a segment of a circle. Since the radius is used to determine the safe working pressure, it is used in this formula, I think, for a matter of uniformity in that the safe terms are used in as many rules as possible. Since the radius is 0.5 the diameter, and the diameter is the factor on which the altitude of the segment is measured, $2 \times R =$ the diameter and, dividing by H, gives the ratio of one to the other.

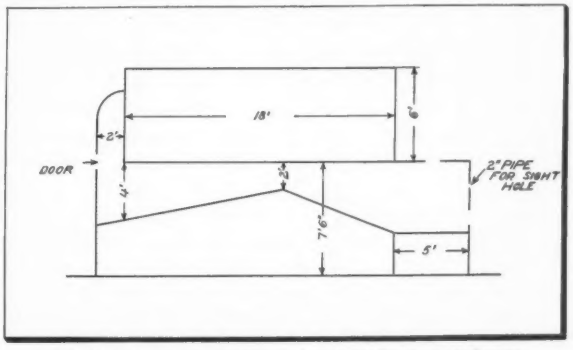
12. The horsepower constant for the 14 by 26-in. engine, running 250 r.p.m., is found like this:—The area of the 14-in. piston is 153.9 sq. in. The piston speed is $250 \times 2 \times 26 \div 12 = 1083+$. The horsepower for 1 lb. m.e.p. is $153.9 \times 1083 \div 33{,}000 = 5.05$; 26 in. vacuum $= 13$ lb. pressure removed from the back of the piston, $5.05 \times 13 = 65.65$ hp.

13. Pounding in a radiator is usually due to poor drainage. The water being unable to escape, condenses the steam, causing water hammer, hence the noise. Try to drain the pipe by giving more pitch, or larger return pipe may be necessary, or air valves may require adjusting.

RECEIVER.

Furnace for Sawdust

IN THE May 1 issue, A. L. M. asks for information in regard to sawdust boiler furnaces. The accompanying sketch shows the construction of our furnace, which gives good results. The grate is 5 ft. long by 6 ft. wide and has round holes, set on a plane 6 in. below the fire door. We have no bridge wall, but build a slanting floor from the level of the grate 8 ft. long, extending



BOILER SETTING USED FOR BURNING SAWDUST

to within 24 in. of the boiler shell, then inclining downward to the rear of the setting. The arrangement is similar to the dutch oven type of furnace with feed hole in the top. We take all our draft under the grates as we get plenty for the top from the feed hole.

This type of furnace has given us the best results for burning fir sawdust and shavings of any we have tried.

T. J. ELLIOTT.

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The Smoking Chimney

Black smoke issuing from the chimney of a power house is unquestionably a nuisance; but, as conclusive proof that the fuel is being less economically consumed in the offending plant, than in another in which similar fuel is burned without the smoke nuisance, the commonly accepted belief, it fails absolutely, unless the smoke is dense and continual. In fact, a coal burning plant where diluted black smoke is discharged from the chimney occasionally or even when slightly black smoke issues continually, may be burning its fuel as economically as is practically possible. The presence of unburned carbon is the cause of black smoke and, when the numerous and greatly varying exigencies of every furnace are taken into proper consideration, it is evident that the waste of a little unburned carbon in the smoke may be more economical than other wastes incidental to guarding at all times against the presence of unburned carbon in the smoke.

Combustion being dependent, in a correctly proportioned furnace, upon the supply of oxygen, the regulation of objectionable smoking is almost entirely a question of air supply, and the remedy for a "smoking" chimney is an increase in the amount of air admitted to the combustion chamber. The remedy is correct, but the fact that is so frequently overlooked is that too much air may have as great or greater a detracting effect upon the economy of operation as the slight scarcity that will produce the undesirable black smoke. For instance, when burning coal having a heating value of 13,400 B.t.u. per pound, about 15 lb. of air is required for the combustion of each pound of fuel. Under such conditions, the chimney is liable to "smoke" at times owing to the varying demands to which the boiler is subject and the fact that perfect fuel supply is not attainable at all times. With a stack temperature of 500 or 600 deg. F., about 180 B.t.u. of the heat necessary to raise the air to the furnace temperature would be rejected into the chimney for each pound of air supply, or about 2700 B.t.u. per lb. of fuel consumed; 10,700 B.t.u. per pound of fuel would then be available for productive work and the various losses that cannot be avoided. This record would be the best that could be attained and the smoke nuisance would not be entirely absent.

Decreasing the air supply 10 per cent would aggravate the smoke nuisance to a considerable extent and also bring about a direct fuel loss, it is true. A lack of a pound and a half of air for the proper combustion of each pound of fuel would be equivalent to reducing the heating value of the fuel by about 1900 B.t.u. per lb. and, though the heat rejected into the chimney by the air supply would be somewhat less, owing to the decreased supply, the heat available for productive work and that for the other wastes would be reduced to about 9070 B.t.u. per lb. of fuel consumed. This value may then be taken as a measure of uneconomical fuel consumption due to lack of proper air supply and apparent by the issuance of very black smoke from the chimney.

In order to remove the visible smoke nuisance liable to occur even when the supply of air is correct—i.e., 15 lb. of air per pound of fuel—an excess of at least 33⅓ per cent would be required, or 20 lb. per lb. of fuel consumed. Under such conditions, about 3600

B.t.u. per lb. of fuel consumed would be rejected into the chimney, leaving but 9800 B.t.u. per lb. available for the boiler and the common losses. This record is considerably poorer than that when a slight smoke was visible, and not much better than when the smoke nuisance was aggravated. Increasing the air supply excess to 66 2/3 per cent of the required amount, practice that is not at all uncommon and is, in fact, far better than is done in many plants, would increase the heat rejected by the air to 4500 B.t.u. per lb. of fuel consumed, so that the heat remaining for boiler use and the unavoidable losses would total to but 8900 B.t.u. per lb. of fuel burned on the grates.

This record is considerably poorer than even that in the case when the smoke fuel loss was very apparent. Unfortunately, this does not limit the losses that are commonly encountered due to attempts to avoid "smoking" chimneys by increasing the air supply—attempts that are made under the delusion that if black smoke can be eliminated, economic fuel consumption will result. Numerous instances are to be found where the air supply is 2 or even 3 times that actually required. Under such conditions it must be evident that the economy in fuel consumption is even poorer than when dense black clouds of smoke issue from the power house chimney.

Smoking chimneys should not be countenanced, however, either from the point of view of economic fuel consumption or the important one of public nuisance; but neither should a rejection of heat into the chimney by a large excess of air supply. Frequent and careful analysis of the gases passing to the smokestack should be made to ascertain the proportion of free oxygen present, the only reliable gage by which the air supply can be measured. Where this cannot be done, the correct air supply can be approximately ascertained and maintained by regulating the supply until a just discernible smoke results. If the furnace and boiler are properly proportioned, this will mark the most economical operation.

Off Duty

What's nitrogen to an engineer?

It hasn't anything to do with CO_2 measurements or steam turbines or superheated steam. To be sure, there's a lot of it in the air we have to use in burning coal or sawdust, yet there it's only a nuisance, since we have to heat it in heating the air, and it doesn't give us anything in return. But we all have to eat.

Nitrogenous food,—yes, we have heard that in the talk of the food experts, who tell us how to avoid clogging our systems and abusing our stomachs. And we can't grow crops without it. That's the farmer's job. Certainly, he grows the crops, but where does he get his nitrogen?

If modern conditions permitted, he would get a lot from garbage and sewage and manures. But city congestion demands quick disposal of these things for health's sake, so that only such of them as are produced on the farm are available to him. Chili has a big natural deposit, and is selling it to the world as fast as possible, so that its supply is due to give out in a century or so. And the useful and despised clover and pea vine do their best to grab some of the nitrogen from the air and store it in the soil, but that's a slow process and requires the land to lie idle while it goes on; not in accord with our ideas of keeping our food-growing land continuously producing salable crops.

But coal, that has nitrogen, especially the bituminous, and the engineering fraternity have been sadly wasteful. In 1911, so says H. R. Moody in Isolated Plant, Chili sold to the world $100,000,000 worth of nitre, and in the 406,000,000 tons of bituminous coal mined in the United States there was $160,000,000 worth of recoverable nitrogen, of which only $3,800,000 worth was saved; $154,000,000 is a nice little sum to throw away in a year, especially when doing so raised the price of food stuffs. Of course, much of this couldn't have been recovered, as it is not possible to treat the coal in domestic and small power furnaces, but in coking coal the nitrogen content can be saved, and we wasted some $8,000,000 a year from 1893 to 1910 in just that way.

Now, we have to find some way to help out the farmer. He cannot go on land robbing forever, or the soil will get so poor that there will be no such thing as reclaiming it. Here come in science and engineering; science, to show the abundance of nitrogen in the air about us and the way to chain it in usable form for fertilizer; engineering, to devise means and methods for carrying out the process on the grand scale required to meet the world's needs. For the chief requirement was power,—heaps of it,—and cheap. Air can be had anywhere, so the nitrate factory must go to the power source, and the industry is developing rapidly. Soon the farms will depend on the engineer, not only for the machines to work the soil and harvest the crops, but for the raw material, fertilizer, which combined, through the soil, with the germinating seed, produces the plant which is the basis of all food, either animal or vegetable. Thus the world comes one further step under the dominion of the power plant engineer, to whom it must turn for light, heat, transportation, clothing, and now for food.

UNITED STATES CIVIL SERVICE COMMISSION will hold an examination for electrical engineer and draftsman, on June 3 and 4, 1914, to fill vacancies at $1200 per annum, in the office of the Supervising Architect, Washington, D. C.

Examination will be on the following subjects, which will have the weights indicated: 1, Theoretical and practical questions in electrical science (covering the subject with special reference to lighting and elevator work in public buildings), 25; 2, Drawing and design (involving ability to design and draw plans, etc., for all apparatus and machinery connected with electrical work in public buildings), 40; 3, Training and experience, 35.

Applicants must have a good common school or high school education and not less than 3 yr. special experience as a draftsman principally in connection with electrical work, or be technical graduates with not less than 10 months' experience as electrical draftsman or practical experience in the installation of electrical wiring or apparatus. Age 22 yr. or over on the date of the examination. In applying for this examination, ask for Form 1312, using the title, Electrical Engineer and Draftsman (Male).

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

Oster Cutting-Off and Reaming Machine

THIS machine is provided with a large single wheel tube cutter, which is stationary, and is mounted on a steel pinion which rests in a bronze bearing.

The pipe to be cut off, rests on a pair of rollers, and by a turn of the hand wheel at the top of the machine the pipe is brought in contact with the cutting disk, and is quickly severed.

A slight pressure on the hand wheel regulates the speed of cutting off.

The 2 rollers which support the pipe while cutting off, are made of steel and revolve in tempered steel bearings, and rest on the bottom of a yoke, which slides up and down in the frame. The disk cutter can easily be removed for sharpening or renewal.

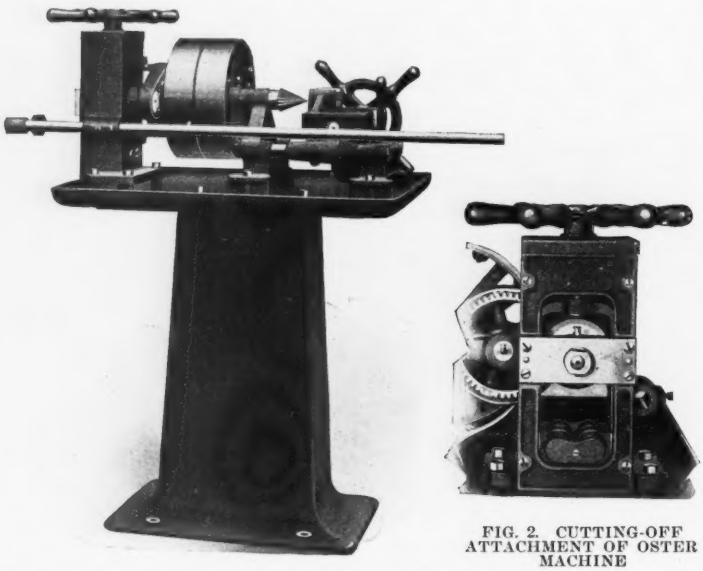


FIG. 2. CUTTING-OFF ATTACHMENT OF OSTER MACHINE

FIG. 1. OSTER CUTTING-OFF AND REAMING MACHINE

The gage rod is adjustable for the different lengths of pipe to be cut off.

Pipe to be reamed is held in the vise jaws, which are opened or closed by a slight movement of the hand wheel at the side of the vise. The open vise enables the operator to change the work quickly.

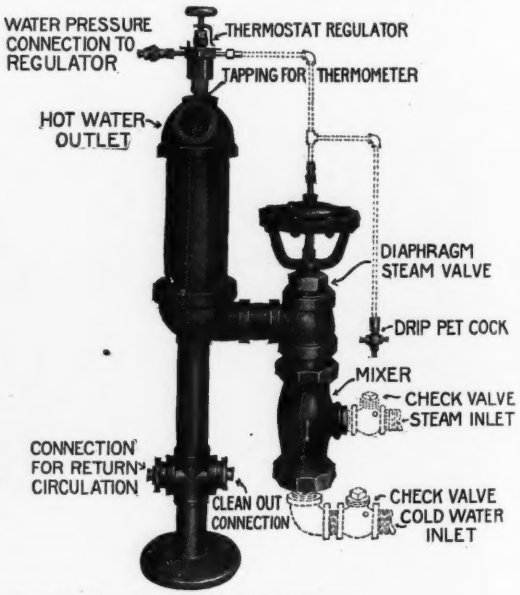
The pressure of the pipe against the reamer is brought about by a slight pressure on the handle mounted behind the vise wheel. This lever handle moves the vise back and forth. The vise is solidly mounted on this frame.

The reamer is held fast by a set screw. It can be easily removed for sharpening when necessary. All bearings are provided with oil cups.

This machine is a recently developed product of the Oster Mfg. Co., 2055 E. 61st St., Cleveland, O.

Weld Automatic Water Heater

IN office buildings, factories, hotels and the like, where hot water is furnished to the occupants, there is usually a great deal of waste due to the occupants turning on the hot water faucet and letting it run until the water becomes hot. If a circulating system is not provided, or the water in the tank is not always up to high temperature, this waste becomes enormous, compared to the amount of water used.



WELD HEATER, SHOWING CONNECTIONS

With a view to stopping this loss, the Weld silent automatic water heater, or steam and water mixer, has been developed by Geo. A. Weld Co., Boston, Mass. The heater consists simply of a mixing device, which is fed through check valves from the cold water system and the boiler. As fast as water is taken from the hot water pipes, it is replaced from the cold water supply and automatically heated to the desired temperature as it passes through the mixer. A thermostat regulator controls the amount of steam which is admitted to the heater by means of a thermostatic valve. This ar-

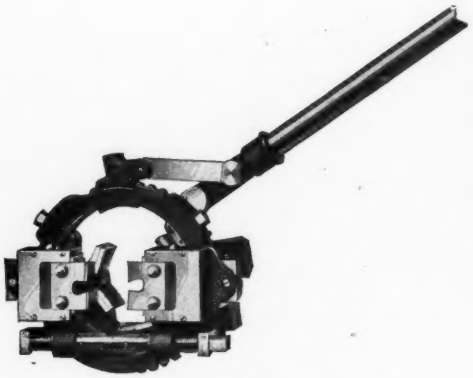
rangement makes the heating instantaneous and automatic, thus doing away with a storage tank and loss of heat due to radiation from it.

To maintain hot water at the faucet, a return connection is made to the bottom of the heater so that water in the mains is kept at a constant temperature.

The Weld heater occupies but little space and meets a demand for an economical live steam water heater.

Beaver Square-End Pipe Cutter

IN adding a new size to its Beaver square-end pipe cutters, a tool to handle pipe from 2½ to 4 in., The Borden Co., of Warren, O., is putting out a larger size, which is a development of cutters in use for a long time for smaller size pipe. The Numbers 1 and 5 cutters have been on the market for the past 2 yr., and some 20,000 have been put into service. The No. 10, the present addition to the line, has the same features, except that it is operated by a ratchet and can be used in any position.



LARGE SIZE SQUARE-END PIPE CUTTER

It has a peculiarly shaped knife, whose cut is so regulated that a thin section of the pipe is cut out instead of depressed, leaving a cut clean, with an absolutely square end and without burr. The manufacturers claim that this cutter will never split pipe, that a square ended pipe has full area, and that a threading die will start on it more easily than when cut off on a bevel; also, that a piece of heavy 4-in. steel pipe can be cut off with one hand in less than 4 min. The details of the tool, which has automatic feed of the knives as the cutting progresses, are clearly shown in the illustration.

Otis Improved Open Heater

IN this new heater, the exhaust steam enters at the side, at the points marked "exhaust inlet," passing directly into the oil separator, then on up to the mingling chamber or spray condenser, where it is mixed with a spray of cold water, so that the water is heated as hot as the exhaust steam. Oil which is removed in the separator, drops to the bottom and is taken through the oil-discharge pipe.

Leaving the mingling chamber, the exhaust steam circulates freely through the steam space in the upper part of the heater, and any excess passes out at the opening on top, marked "exhaust outlet." As all water of condensation is left in the heater, any steam which escapes is free from water, and can be used for other heating purposes.

Feed water enters through a pipe controlled by an automatic regulator at the side of the shell, turns upward and is thrown into the mingling chamber in a conical spray. The heated water then falls upon the spreading cone, from which it is passed to the heating pan, and flows over the edge of that pan in a thin film before it can mingle with the water in the heater.

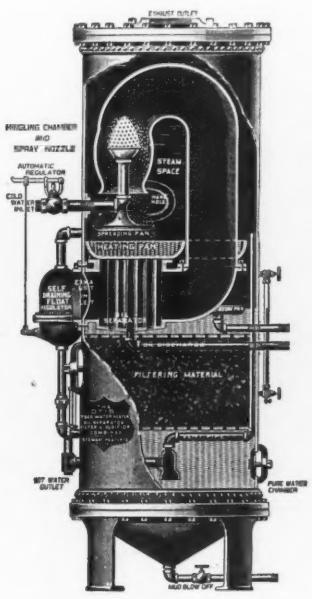


FIG. 1. THE OTIS IMPROVED OPEN HEATER, OIL SEPARATOR AND FILTER

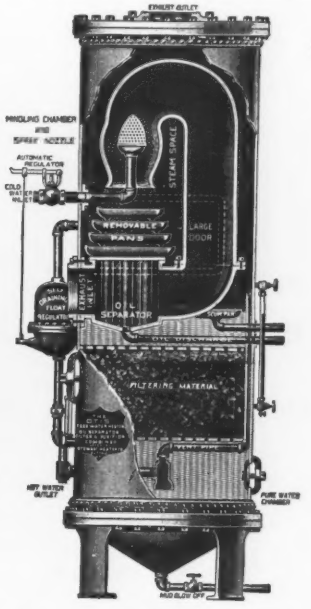


FIG. 2. OTIS IMPROVED OPEN HEATER WITH CAST-IRON PANS

It has attained a temperature such that it is in condition to deposit its impurities, and as it passes down through the filtering chamber, the filtering material takes up the precipitates so that pure water enters the chamber at the bottom, which is of large capacity to allow any particles of sediment that may reach that chamber to settle to the bottom, from which they can be removed through the front blowoff. Water is kept at a constant level in the part above the filtering material, by means of a self-draining float regulator, which controls the cold-water inlet.

This float has a brass-tube stem, through which any water that might enter the float by leakage will pass off, thus maintaining the buoyancy of the float, which is made of copper and tested to resist an external pressure of 200 lb. This float is placed in a separate chamber connected to the shell, top and bottom, so that the water level in the float chamber is always the same as that in the heater.

Access to the filtering chamber is had through a hand-hole plate, permitting the chamber to be refilled in a few minutes. At the water level, a scum pan is placed, which removes any oil or floating impurities before the water passes through the filter.

Water is taken from the heater at boiling temperature, from the center of the water chamber, by means of an inlet having a vent pipe leading into the steam space. In case the supply of water to the heater is shut off and the water level drops, the pump will stop pumping. The volume of the heater is such that it acts as an expansion tank to overcome pulsation of the exhaust and of the feed pump, and also serves as a receiver or condensation tank for water coming from the heating system. All exhaust steam should be passed through the heater, so that the separator may remove the oil, and then steam not wanted for heating the feed water can be taken from the exhaust outlet for such use as may be desired. The shell of the heater is of steel, the heads of cast iron, with cast-iron supporting legs, which keep the conical base well above the floor, permitting easy access to the blowoff.

In case it is desired, the heater is furnished with a series of removable cast-iron pans, on which scale-forming material may collect, these pans being supported above the oil separator and removable through a large door in the side of the shell. The heater is made in sizes from 30 up to 2000 hp., with exhaust pipe connections from 3 up to 18 in., according to the capacity of the heater, and water pipe connections for the inlet from 1 up to 4 in., and for the outlets from 1¼ to 5 in. The heaters are manufactured by the Stewart Heater Co., of Buffalo, N. Y. Each heater is thoroughly tested before leaving the factory and is guaranteed by the manufacturers in every respect.

Monash Thermostatic Vacuum Valve

THE principal enemy of thermostatic valves in general, is the amount of dirt and sediment in the heating system, which must be taken care of, and is the principal cause of trouble; but another objectionable feature is the trouble due to the collapse or rupture of the thermostatic diaphragm.

One feature of the Monash thermostatic valve, used in connection with the Monash noiseless system of vacuum heating, is that, when steam comes to the valve chamber, the valve closes instantly without any steam pressure coming in contact with the thermostatic member. The diaphragm, being entirely relieved of all pressure caused by steam remaining in the valve case, cannot rupture itself. There is nothing attached, and no adjustment to make.

In no way can any dirt or sediment pass through the valve opening into the expansion chamber, for the reason that there is an ample dirt pocket in advance of the valve seat, with a deflector to throw this dirt and sediment to the bottom of the pocket, from which it can be removed from time to time, as may be necessary, by the clean-out.

A pocket is provided in the expansion chamber to receive the diaphragm, which is simply dropped in. No adjustment of any kind is required. Provision has been made by the use of a spring bumper to take care of the over expansion of the diaphragm and prevents its collapse, an entirely new feature in thermostatic valves, which does away with the renewal of the diaphragm.

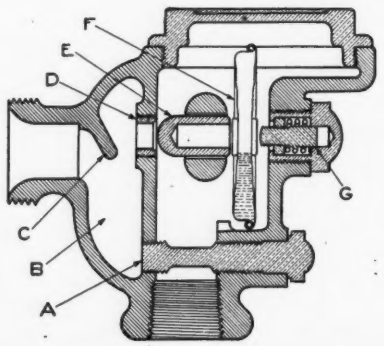


DIAGRAM OF MONASH THERMOSTATIC VACUUM VALVE

Referring to the diagram, A is the clean-out; B, dirt pocket; C, deflector; D, valve seat (phosphor bronze); E, valve (phosphor bronze); F, diaphragm (special metal); G, spring bumper.

The manufacturer of this valve is the Monash Engineering Co., 1407 W. Jackson Blvd., Chicago.

AT THE STATION of the Philadelphia Electric Co., near Christian St., there will be installed 2 turbo-generator units of immense size. One will be of 35,000 kw. capacity at 13,200 volts, 60-cycle, 3-phase, and the other 30,000 kw., 25-cycle. For the bigger machine, the length will be 63 ft., the width 21 ft. 7 in., and the height 15 ft. 10 in., weighing complete 600 tons. The turbine element will have 13 stages, using steam at 215 lb. initial pressure and 150 deg. superheat.

It will exhaust against 1.5 in. vacuum into a condenser having 50,000 sq. ft. surface, the steam entering at the top and passing around the sides of the shell in a volute chamber, then radially through the banks of tubes to the center of the shell where the air is removed. The condensate will trickle down to the bottom over the hottest water tubes, these having a 2-pass arrangement, so that the condensate is removed from the condenser only a few degrees below the temperature corresponding to exhaust pressure. Full rated capacity will be with 0.9 power factor and a kilowatt-hour is expected for 12.6 lb. steam, while at most efficient load, 25,000 kw., the steam consumption will be 11.9 lb. per kw. hr. The turbine units are Curtis type, built by the General Electric Co., and the condensers, designed by the Westinghouse Machine Co., which also supplies the pumps, are being built by the Southwark Foundry & Machine Co.

Pipe Expansion Safeguard

IN the design of a system of steam piping, one of the most important problems is the proper provision for the variation in length of the pipe, which occurs every time the steam is turned on or off.

Steel, such as is used in the manufacture of ordinary "Standard" or "Merchant" pipe, elongates about 0.008 in. per 100 ft. of length for each degree Fahrenheit of variation in temperature. In high-pressure lines carrying steam at 150 lb. gage pressure, there is a temperature rise of 326 deg. above the normal underground winter temperature of 40 deg. F. Hence, under these conditions, the total amount of expansion for every 100 ft. of steel pipe is 2.6 in.

The interior forces in the metal produced by expansion are great, and the entire line must be allowed to expand freely and at the same time be properly anchored and guided. If this is not done, leaky joints or broken flanges are sure to result, and in some cases the piping itself may be distorted.

The movement or travel of the piping due to expansion or contraction is cared for in modern power houses by long radius bends, by double swings with screwed fittings, and by expansion joints.

In short runs of piping and where there is unlimited headroom, long radius bends are ordinarily used with good results; but in long runs underground or in locations where headroom is limited, bends are often impracticable.

In some cases, the double swing arrangement may be used on low-pressure lines; but this necessitates the use of screwed piping and oftentimes limited headroom makes this method impossible.

The natural solution of the problem is a reliable expansion joint which will not leak under either steam or water pressures, and which will require no attention after being placed in service.

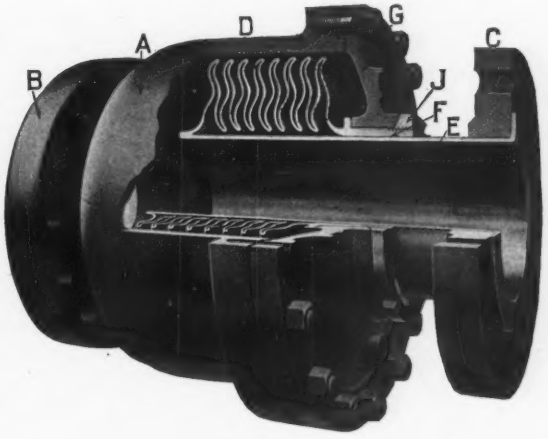
A line of joints which care for the expansion by corrugated copper expansion members is supplied by the Alberger Pump and Condenser Co., of New York City, the Wainwright joints having a corrugated cylinder with cast-iron or steel end flanges, which for low pressure up to 20 lb. is used without reinforcing, and for high pressure up to 160 lb. is made of heavier copper and reinforced outside and inside with cast-iron rings to divide the expansion and with a smooth hard brass cylinder inside the corrugated cylinder, to limit the travel. It is found that this type is limited in its application as frequent alternate expansions and contractions tend to crystallize the soft copper.

To meet all conditions, there is provided the Alberger high-pressure steel expansion joint, constructed as illustrated.

In this joint, a nest of circular disks, stamped from steel plates having an exceptionally high elastic limit, is welded together, forming a flexible bellows, which absorbs the movement of the pipe line.

One end of the nest is welded to the steel tube, E, and the other end to the steel sleeve, F, the latter being held in place by the nut lock, J. Leakage between sleeve F and casing head G and between casing head G and casing A is prevented by special gaskets. Only the outside of the bellows is under steam pressure, so that no condensation can collect within the disks themselves. The working portion of the joint is protected from outside injury by the cast-iron casing, A, and the casing head, G, which are designed to withstand pressures up to 200 lb. per sq. in. If the customer desires, flange B will be supplied with a raised face inside of the bolt circle. Flange C is practically furnished in this way due to the overlapping pipe.

When building this expansion joint, the steel disks are welded together and the joint is assembled with the bellows in a neutral position; that is, with none of the working parts under strain. When in service, half of the total amount of linear travel is taken up on either side of this neutral position. After assembling and testing, spacers are used to force flange C from the neutral position to the maximum one. The overall length at the maximum position is the face-to-face dimension as tabulated for the different sizes. The expansion joint is shipped with these spacers in place and they should not be removed until after the fitting has been installed. To safeguard the expansion joint against excessive movement, flange C will strike the lock-nut, J, when the maximum linear movement for which the joint is designed, has been reached.



ALBERGER HIGH-PRESSURE STEEL EXPANSION JOINT

It is possible to supply anchor feet alone or with 2 side outlets with these expansion joints, which in many installations will simplify the piping.

The anchor foot is cast as a part of the casing and forms a support, a guide and anchor, both for the expansion joint and the adjacent piping.

Sizes larger than 6 in. in diameter should be supplied with anchor feet to carry the weight, unless special supports are furnished by the purchaser. Side outlets may be tapped on either or both sides of the horizontal center line of the casing and may be furnished in any size up to one-half the diameter of the main run. This expansion joint when tapped with side outlets often takes the place of a tee or a cross and thus cheapens the cost of the piping.

The joint may be used as a receiver in pipe lines to collect water of condensation and is furnished with drain connections tapped at the lowest point of the cast-iron casing.

News Notes

THE REFRIGERATING WORLD has removed its offices to 30 Church St., New York City.

JACOB D. REED, proprietor of the Union Knitting Mills, at Schuylkill, Pa., has decided to install his own electric power plant. Specifications and plans have been drawn, and bids on the installation of the machinery and fitting up of a complete power plant are being invited. The plant will be of good size.

THE NORTHERN EQUIPMENT CO., of Erie, Pa., manufacturers of Copes boiler feed regulators, Copes pump governors and Neco high and low water alarms, recently made arrangements with the De Ved-Kissick Co., merchant engineers, to represent them in New York City. The De Ved-Kissick Co. is located at Room 403, Singer Bldg., and for several years has been successfully representing the Vulcan soot blower.

EXCAVATION IS UNDER WAY for a brick addition to the boiler house of the Cambridge Gas Light Co., Cambridge, Mass., from designs of Charles T. Main. The present boiler house contains several 72-in., return-tubular boilers; the new one is designed for 6 150-hp., Babcock & Wilcox boilers of which 2 are to be installed at once. The space ultimately to be occupied by the other 4 boilers will, for the present, be utilized for the blacksmith's shop.

THE SIMS CO., of Erie, Pa., manufacturer of feedwater heaters, hot-water heaters and other steam specialties, announces that its New York office is now located in the Marbridge Bldg., Broadway and 34th St., Room 655, where its representative, P. A. Moulton, will give prompt personal attention to all inquiries.

Earl F. Scott, Candler Bldg., Atlanta, Ga., has been appointed selling representative for the Sims Co., covering the State of Georgia.

THE MIDDLE WEST UTILITIES CO., which owns and operates the utilities interests at New Albany, Ind., has acquired the plant of the Southern Indiana Power Co., at Bloomington, the capital stock of which was $800,000. Chester P. Wilson, of Indianapolis, is at the head of the Indiana plants, since Martin J. Insull went to Chicago. Samuel J. Insull is the promoter of the Middle West Utilities Co., and controls several hundred public utilities properties in various States. The latest acquisition is in Lawrence County, at Williams, on White River, and its owner operates quarries in a valuable stone district. Several months ago, the City Council of Bloomington granted a franchise to the company whose transmission lines extend to Monroe County.

JUNE 26 AND 27, the Stationary Engineers of Connecticut will hold their annual convention in Bridgeport, in the Eagle's Hall, Madison Ave., and in connection with this, there will be an exhibition of mechanical goods by manufacturers and supply houses, which will be open, free of charge, to the public. The exhibition will give opportunity to see the goods of each exhibitor to the best advantage, and for asking and answering of questions in regard to operation and features of the different devices. The exhibit has the support of the Manufacturers' Association and Board of Trade of Bridgeport, and the indications are that it will be the largest exhibit of such material ever held in the State.

Committee of arrangement for the convention and exhibition is as follows: F. J. Quinlan, Chairman; Edw. S. Birge, Secy. and Treas.; C. D. Osborn, Secy.; W. Goodick, P. J. Grace, Jos. Bellwood, A. McNiel, Jr., F. Anderson, F. S. Buckley, N. S. Beushan, E. J. Grace, C. M. Dowd.

UNITED STATES CIVIL SERVICE COMMISSION will hold an examination for junior fuel engineer, for men only, on June 3 and 4, 1914, to fill vacancies in the Bureau of Mines, Washington, D. C., at salaries ranging from $1200 to $1500 per annum. The duties will be to assist in tests of boiler and other furnaces, of auxiliary equipment affecting efficiency in the use of fuels, investigation of fuel-burning methods and machinery, and the compilation of data and making reports. An educational training equivalent to that required for graduation in mechanical engineering from a college or university of recognized standing, and at least 2 years' experience in work dealing largely with fuel engineering and the management of furnaces, are prerequisites for consideration for this position. In applying for this examination, ask for application Form 1312, using the title, Junior Fuel Engineer (Male).

UNITED STATES CIVIL SERVICE COMMISSION announces an examination for aid, on June 3 and 4, 1914, to fill vacancies in the Bureau of Standards, Department of Commerce, at salaries of $600 to $720 a year. The work is scientific and technical in character, consisting principally of physics, chemistry, and mechanical and electrical engineering. Young men filling successfully the position of aid are eligible for promotions in the lines of work in which they have become efficient. The following subjects will have the relative weights indicated: Elementary algebra, geometry, and trigonometry, 30; general physics, 30; elementary mechanical drawing, 20; education, training and experience, 20. Graduation from a mechanical training, technical, or scientific school or equivalent training in a scientific or technical laboratory is a prerequisite for consideration for this position. In applying for this examination, ask for Form 1312, using the title, Aid (Male).

Books and Catalogs

A CONVENIENT REFERENCE BOOK for the exporter or the manufacturer who is interested in foreign trade, is the Bulletin of Imports and Exports of Merchandise into and from the United States by Countries, and Principal Articles, which has just been published by the Bureau of Foreign and Domestic Commerce and is sold by the Superintendent of Documents, Government Printing Office, Washington, D. C., for 15 cents a copy. A glance at this pamphlet affords the business man a bird's-eye view of the character and volume of our commerce with any foreign country, as it gives the quantity and value of its principal purchases from us and its sales to the United States for the years 1912 and 1913.

PRACTICAL GUIDE for Interior Wiring Systems is a leaflet by M. W. Ehrlich; 10 cents. Gives concise data for power and lighting circuits, showing wire and conduit sizes for direct-current systems without figuring. It is for sale by J. Wilmore, 687 Wales Ave., New York City.

ELECTRIC FURNACES for Making Iron and Steel, Bulletin 67, from the Bureau of Mines, Washington, D. C., by Dorsey A. Lyon and Robert M. Keeney, contains 142 pages, reviewing the development of electric furnaces for pig iron and steel manufacture, and discussing the problems that remain to be solved in the use of electric furnaces for the smelting of iron ores and the production of pig iron at a profit on a commercial scale.

More than one copy of the limited free edition of the bulletin cannot be given to one person. When the free edition is exhausted, copies may be obtained at cost price, 20 cents, through the Superintendent of Documents, Government Printing Office, Washington, D. C.

THE WESTINGHOUSE ELECTRIC & MFG. CO. has recently issued Section 3164, covering Motor-Driven Laundry Machinery. This forms one of the series of publications which this company is now issuing, dealing with motor drive as applied to various industries. The booklet is well illustrated, describes the qualifications necessary for motor drive in this class of work, and shows a number of installation views. A number of installations are also described, showing the amount of power required for the various machines and also the monthly kilowatt-hour consumption of the different plants.

Westinghouse Eectric Type I Oil Switches, Leaflet 3745, describes and illustrates the construction of this type of oil switch which is intended for use on direct or alternating current series lighting circuits and for controlling inductive loads of small capacity.

"STEELCRETE" mesh for the construction of machine-tool guards and other protecting devices, is the subject of a booklet from the Consolidated Expanded Metal Cos., of New York, Chicago and Pittsburgh.

A folder from the same company describes a slab computer for calculating reinforced concrete slabs.

A WAR MAP of Mexico is being issued by the Magnolia Metal Co., 113-115 Bank St., New York. This map is 14¾ by 11 in. The company will be pleased to send it free of charge upon application, while the supply lasts.

CINCINNATI GEAR duplex Corliss steam driven air compressors are described and illustrated in Bulletin L-523-A, from the Laidlaw-Dunn-Gordon Co. (International Steam Pump Co. Successor), of Cincinnati, O.

CONTROL SYSTEMS for newspaper and rotary magazine presses are described and illustrated in Bulletin No. 242 from Sprague Electric Works of General Electric Co., New York.

A NEW CIRCULAR, giving prominent features of Jefferson unions, has been received from Jefferson Union Co., Lexington, Mass.

A BOOKLET ENTITLED "Why," relating to the use of Detroit stokers by automobile manufacturers, comes from Detroit Stoker Co., Detroit, Mich.

ERIE PUMP AND ENGINE Works, Erie, Pa., recently issued Bulletin No. 29, relating to low head centrifugal pumps.

OHIO J. D. brass globe, angle and check valves, designed for 150-lb. working steam pressure, are illustrated in a booklet lately issued by The Ohio Brass Co., Mansfield, Ohio.

OZONE APPARATUS, including laboratory and industrial ozonators, motor-generator set, ozone mixer and air filter, is the subject of a new booklet from Sprague Electric Works of General Electric Co., New York.

HYDRO VOLUME AND PRESSURE recorders are described and illustrated, and charts on measuring the flow and pressure of gases are given in Catalog B, just received from Herman Bacharach, 14 Wood St., Pittsburgh, Pa.

VACUUM TUBE Lightning Arresters, Bulletin No. 45,600, from General Electric Co. describes aluminum lightning arresters for use in connection with railway signal circuits. It supersedes the company's previous bulletin on the subject.

MULTIPLE EXPANSION BALANCED high-speed steam engines for motor boats, dynamos, blowers, pumps, automobiles, etc., are described and illustrated in a pamphlet lately received. These engines are designed and built by J. M. Clark, Whitestone, L. I., New York.

PORTABLE EMERY GRINDERS, electric and rope-driven, and other portable tools, are illustrated in a circular just issued by Stow Mfg. Co., Binghamton, N. Y.

Bulletin No. 88 relates to the Stow 2-spindle drill.

AMONG RECENT PUBLICATIONS dealing with the different lines of apparatus manufactured by the Westinghouse Electric & Mfg. Co., are the following:

Section 3082, Motor-Driven Pumps. This publication has an attractive art cover, and as the title indicates, describes pumps of various kinds driven by electric motors. The booklet is profusely illustrated with views of installations of pumps of various kinds, performing duties of a varied nature. Tables are given showing the frictional heat in wrought-iron pipe, horsepower for pumping, standard dimensions of pipe, and atmospheric pressures, equivalent heads and suction lifts.

Ironing a Pleasure, Folder 4281, describes the household and travelers' iron manufactured by the Westinghouse Electric Co. On the front page is a picture of the cutout representing "Dorothy" ironing. This device is furnished dealers and central stations by the Westinghouse Electric Co. for use in their campaigns.

Westinghouse 56 in. d.c. Ceiling and Column Fans, Folder 4282, describes and illustrates ceiling and column fans, giving weights, prices, etc.

Type K D Battery Charging Panels for Two-Wire Systems, 50 to 250 Volts, Leaflet 3719, describes and illustrates the panels for systems above mentioned for lighting and electric vehicle charging. Typical diagrams of connections are shown.

Trade Notes

THE HORNELL ELECTRIC CO., Hornell, N. Y., has let the contract for the installation by the General Electric Co. of 2 1000-hp. steam turbine electrical generators in its plant on Hill St.

THE NELSON VALVE CO., of Chestnut Hill, Philadelphia, Pa., reports that, up to date, the sales of Nelson valves have shown an 11 per cent increase over those for the corresponding period of 1913.

AFTER CAREFUL STUDY of all conditions, the Holyoke Street Railway Co., Holyoke, Mass., has decided to use direct current as being better suited for its distribution of power than alternating current, and has placed an order for a 1200-kw. General Electric generator and a 30 and 60 by 54-in. cross-compound Rice & Sargent engine.

AT THE ANNUAL MEETING of Stockholders of the Joseph Dixon Crucible Co., the officers were elected as follows: President, Geo. T. Smith; Vice-President, Geo. E. Long; Treasurer, J. H. Schermerhorn; Secretary, Harry Dailey; Assistant Treasurer, Albert Norris; Directors, Geo. T. Smith, Wm. Murray, Geo. E. Long, Edward L. Young, Wm. G. Bumsted, J. H. Schermerhorn and Harry Dailey.

AMONG RECENT sales of Economy turbines reported by Kerr Turbine Co., Wellsville, N. Y., are the following: 13 units for driving pumps, Swift & Co.; 6 units for driving pumps, Crane Co.; 3 turbo pumps, Lackawanna Steel Co.; 1 turbo pump, American Sheet & Tin Plate Co.; 400-hp. unit, Carnegie Steel Co.; 150-hp. belted unit Bodcaw Lumber Co. Turbo-generators as follows: 500-kw. unit, Coy Paper Co.; 2 250-kw. units, Standard Oil Co.; 200-kw. unit, Taggart Bros. Paper Co.; 150-kw. units, Glasgow Electric Light & Ice Co., City of Ravenna (Ohio), and Kerite Insulated Wire & Cable Co.; 125-kw. unit, Ypsilanti Reed Furniture Co.; 100-kw. unit, Gulf Fisheries Co.

THE A. S. CAMERON Steam Pump Works, 11 Broadway, New York, announces the opening of a branch office and warehouse in each of the following cities: Birmingham, Ala., American Trust Bldg., H. M. Perry, Mgr.; Chicago, Ill., People's Gas Bldg., M. P. Frutchey, Mgr.; Cleveland, Ohio, Williamson Bldg., W. A. Armstrong, Mgr.; Duluth, Minn., Providence Bldg., S. H. Hill, Mgr.; Houghton, Mich., Thos. F. Lynch, Mgr.; Knoxville, Tenn., Holston Nat'l Bank, L. F. Thompson, Mgr.; Los Angeles, Cal., W. A. Townsend, Mgr.; Philadelphia, Pa., Arcade Bldg., Phil. Weiss, Mgr.; Pittsburgh, Pa., Farmers' Bank Bldg., W. B. Brendlinger, Mgr.; St. Louis, Mo., 300 N. Broadway, A. A. Bonsack, Mgr.; Seattle, Wash., Colman Bldg., R. W. Douglass, Mgr.

These branches will carry a stock of Cameron pumps and repair parts, for single and multi-stage centrifugal pumps for low head and high head service, in mining, contracting, power plant, marine, and all other kinds of pumping work.

PRACTICAL ENGINEER

Trade-mark, Reg. U. S. Pat. Off.

SEMI-MONTHLY

PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH.

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Advertisements in this section are inserted under regular headings.

No display type allowed, but the first three words may be set in capital letters.

About nine words make a line. Minimum space sold, two lines.

Under classification "Position Wanted," advertisements not exceeding four lines will be inserted once for subscribers free of charge.

All copy should be received at Chicago office 18 days before date of publication.

Circulation of this issue, 22,500.

Technical Publishing Co.

537 S. Dearborn Street

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Position Wanted

POSITION WANTED—As Chief Engineer in Institution, with 10 years' experience in Institution work. Can give best of reference. C. H. Mitchell, 1403 Congress St., Portland, Maine. 6-1-1

POSITION WANTED—As Chief Engineer or assistant in small town. Refrigerating experience. Best of references. Licensed in Chicago. Address M. J. W., 1951 W. Jackson Blvd, Chicago, Ill. 5-15-2

..POSITION WANTED—As Gas or Oil Engine Operator, with 4 years' experience. Address Box 46, Morton Grove, Ill. 6-1-1

POSITION WANTED—By industrious and capable young man as engineer in power station. I. C. S. graduate. 5 years' exp. on large reciprocating units and large steam turbines. A. C. and D. C. apparatus. At present engineer in large power station. Chicago license. A1 references. Address Box 347, Practical Engineer. 5-15-2

POSITION WANTED—As Engineer of Water Works, Ice Plant or Electric Light Plant. Town of 2000 or 3000. South preferred. 8 years' experience installing and operating. References, R. R. Ricoss & Son, Jensen, Fla. Address T. R. Christian, Salerno, Fla. 5-15-2

POSITION WANTED—By young man as assistant or oiler. First class. Minnesota license. 7 years' experience. References of the best. Correspondence invited. Guy Bilyen, McGregor, Minn. 5-15-2

POSITION WANTED—With Engineering Supply House, by young man who holds I. C. S. diploma; also second class Mass. fireman's license and has two years' experience. Address Edward S. Daniels, 113½ Bridge St., Salem, Mass. 5-15-2

Wanted

WANTED—A small ice-making and refrigerating plant with a daily capacity of about 10 to 15 tons is wanted by a subscriber. A second-hand plant preferred. Give full particulars. Address Box 341, Practical Engineer. tf.

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Help Wanted

MR. ENGINEER—If you are tired of the daily rut of your job, and are ambitious to make a way for yourself in the selling end of the engineering line, we have something unusual to offer you. Become a sales engineer and earn three to six times as much as your present salary. You can do it without any risk whatsoever, but you must possess certain qualifications. Write us and we will tell you if you are elegible. We manufacture boiler appliances of the highest merit and standing, selling as high as $400 per boiler, and yielding in commissions as high as $100 per boiler. One sale may mean more than your week's salary. Write us. Box 349, Practical Engineer. tf.

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FOR SALE—2 Buckeye steam engines at bargain prices. 1 12x21-in., 85-hp., 185 r.p.m., 85-lb. steam pressure, flywheel 6 ft. diameter, 22-in. face. 1 11x18-in., 70-hp., 200-r.p.m., 85-lb. steam pressure; flywheel 4 ft. diameter, 14-in. face. Changed to motor drive. Must move at once. Write today. The W. H. Mullins Co., Dept. A, Salem, Ohio. 4-15-6

FOR SALE—One 95-hp., 3-cylinder Westinghouse producer gas engine and complete equipment for operating suction type. Constant use one year. Practically new. Address Box 345, Practical Engineer. 4-15-6

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FOR SALE—At a Bargain. New 5x6, 4-cylinder governor-controlled engine, fully equipped with carburetor magneto Will sell for much less than cost. Fred Hanson, 570 Prior Ave., St. Paul, Minn. 6-1-1

TRAVELING CRANE—Wooden—For Sale Cheap. 15-ton capacity, 65-ft. span, suited for either motor or wire rope drive. Write Box 346, Practical Engineer. 4-15-6

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PATENT YOUR INVENTION. Send sketch for free expert search and report as to patentability. Books on inventions and patents, and book of references from congressmen, manufacturers, bankers and inventors sent free. John S. Duffie & Co., 612 F St., N. W., Washington, D. C. tf.

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. 186 McGill Bldg., Washington, D. C. tf.

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ENGINEERS' POCKET MANUAL, 175 pages, edited by University of Tennessee, will be mailed every subscriber sending in NEW subscriptions (not your own) to Practical Engineer. Gilt edges; bound in leather.

Miscellaneous

ENGINEERS—DO YOU WANT to utilize your exhaust steam for heating or drying purposes, without back pressure on your engine? If so, address Monash Engineering Co., 1413 W. Jackson Blvd., Chicago, Ill. tf.

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Sparks From The Advertising Pages

One of the best things we have read in a long while is "The Price of Civilization," written by A. G. Hammersfahr, Advertising Manager of Colliers' Weekly. Although it does not talk of boilers, engines or traps, it so interestingly tells of the part advertising plays in the life of all, from editor to engineer, that we are herewith reprinting it:

"If you and I lived in the Jungles of Brazil:

"We should have no house rent to pay—
Telephone service would cost us nothing.
There would be no street car fares to charge up to 'petty cash'—
Theatres and motion picture houses would be no drain on our purses—
Never would the butcher, the grocer, or the ice-man send us his bill—
Automobiles and the good times that go with them would burn up none of our money—
And we should never be sued for libel.

"These are things that go only with life in civilized communities. They are 'the Price of Civilization' that you and I must pay.

"Civilization constantly increases our requirements; and yesterday's luxuries become today's necessities.

"The 'high cost of living' would never keep us awake o' nights—if we lived in the Jungles of Brazil; but—

"If we were lucky enough to find a 15-cent package of breakfast food, a 10-cent can of baked beans, a 5-cent box of crackers, or a plug of tobacco at the solitary store of some distant river-point—many, many miles from our jungle hut—the price we would have to pay would be fabulous!

"Supply inevitably follows demand; and it is such factors as supply, demand, cost of production, and cost of distribution that inevitably determine the price of any commodity.

"Living in the cities and towns, we *have* many things, we *see* many things, we *want* many things, we *buy* many things—sometimes more than we *need*. And all these things cost money.

"Civilization increases our requirements and our wants; but it increases our *comforts*, too.

"Civilization and ***honest advertising*** go hand-in-hand. They are 'part and parcel' of each other, for honest advertising is one of the most potent influences in the progress of humanity.

"Honest advertising increases distribution and increases consumption; but it standardizes and guarantees the advertised commodity."